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THE

DIAMONDS, COAL AND GOLD

OF

INDIA

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THE

DIAMONDS, COAL AND GOLD

OF

INDIA

THEIR MODE OF OCCURRENCE AND DISTRIBUTION

38784

BY

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"JUNGLE LIFE IN INDIA; OR, THE JOURNEYS AND JOURNALS OF AN INDIAN GEOLOGIST"

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PREFACE.

A GROWING spirit of inquiry in reference to Indian mineral deposits has led me to prepare a series of Papers descriptive of the mode of occurrence and distribution of several of the more important among them.

Three of these Papers on the Diamonds, Coal, and Gold, which were first published in the journals of learned societies,* are now offered to the public in a more compact and accessible form.

The design of this work is that it may be used as a handbook to the detailed accounts published by the Geological Survey of India, and by other authorities, in numerous scattered publications, to which full references are given.

That a plain and, at the same time, comprehensive statement of the Geology of the more useful mineral deposits of India was urgently wanted is amply testified by the scanty and too often erroneous manner

* Report of the British Association for 1879, "Journal of the Scientific Proceedings of the Royal Dublin Society," and "Journal of the Royal Geological Society of Ireland" for 1880.

in which the subject is dealt with in standard works on Geology. In spite of the fact that the systematic exploration of the Geology of India has been in operation for a quarter of a century, old exploded hypotheses have been passed on from one text-book to another, and their statements regarding the age of the coal, the diamonds, and many other mineral productions far from represent the present state of our knowledge.

While these pages were passing through the press, I have succeeded, I believe, in identifying the mine where the Koh-i-nur was discovered. The results of this inquiry, together with a proposed explanation of the myth regarding diamond mining in India, as described in the travels of Marco Polo, Sindbad the Sailor, &c., will be found in the Appendix.

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THE

DIAMONDS, COAL AND GOLD OF INDIA.

CHAPTER I.

DIAMONDS.

To say that India has for many years been famous for her diamonds would be to enunciate a truism with which every one is familiar. It is not an easy matter, however, to determine for how long this has been the case, still less so to fix with approximate accuracy any period of the world's history as being that when the precious gem first came to be esteemed in the East. At least 3,400 years have elapsed since the first account of it in the "Mahabaratta" (B.C. 1500) was written—and it may have been known long previous to that. By some it is thought that the Koh-i-nur belonged to King Vikramaditya (B.C. 56), a personage who seems to have been most ubiquitous, if a tithe of all that is said of him could be believed.

I show below, when describing the diamond localities of Sambalpur, that Ptolemy possessed a remarkable amount of information regarding them. Tavernier

was of opinion that those of Soumelpour, a distinct locality, were the oldest workings in India.

In this account I have attempted to give references to the most important authorities* on the subject of Indian diamonds and diamond workings both ancient and modern, but my knowledge of the ancient literature of India is too limited to enable me to give a *résumé* of what may be recorded on the subject in native writings. The late Professor Blochmann had, I know, culled from many sources notices in Arabic, Persian, and Urdu on the subject of the mineral productions of India, but these have, unfortunately, never been published.

According to Captain Burton, the Indian diamond was first made famous in Europe by the French jeweller, Jean Baptiste Tavernier (born 1605, died 1689), who made six journeys to India in order to purchase precious stones. Tavernier himself, however, alludes to a previously existing trade, which at least dates back to the time of Marco Polo. Before the year 1728, the production of diamonds was practically limited to India and Borneo, but in that year the first diggings were opened in Brazil.

Tavernier did not visit Borneo, he tells us, in consequence of having been informed that the queen of that island would not permit the removal of any gems out of her dominions. But the courageous old traveller seems to have been ready to go anywhere in the pursuit of his trade, undeterred by risks and dangers. He seems to have fared well in India, and

* One of the most complete accounts of the diamond deposits of India is by Karl Ritter ("Erdkunde Asien," vol. vi. Berlin, 1836).

often alludes to the courtesy, and even the loving-kindness, of the natives.

I had intended to add to this Paper an account of all the famous diamonds which have been found in India;* but, at the very outset of my investigations, I have met with so many contradictory and conflicting statements, that I find it will require more time than is available to me at present to hunt up authorities and attempt a reconciliation.

As an example, I may state that, according to some authorities, the Pitt or Regent diamond is said to have come from Borneo; by others, from the mines at Purtial. Similarly the true history of the Koh-i-nur is enveloped in much obscurity.

Distribution of Diamonds in India.

There are in India three extensive tracts, widely separated from one another, in which the diamond has been sought for from the earliest periods of recorded history. Besides these principal tracts there are others where, although the fact of the occurrence of diamonds has been recorded, our knowledge as to the circumstances connected therewith is less perfect. But, with regard to the three principal tracts, it may now be fairly claimed that our knowledge of the geology of India enables us to fix the limits with approximate accuracy within which the diamond-bearing strata occur, and outside of which it would be useless to look for them. Moreover, we may venture perhaps to extend within those limits very considerably

* The works on "Diamonds and Precious Stones," by MM. King, Streeter, Dieulafait, and Harry Emanuel, may be referred to for information on these points.

the areas in which it may reasonably be anticipated that the gem may be sought for successfully.

The most southern of these tracts is one which has long borne a familiar name, which, however, must be characterized as being to a certain extent a misnomer. It falls to the lot of those who live in these modern days of accurate research to be called upon to give up some of their earliest and most cherished beliefs, and it will be unacceptable to some, perhaps, to hear that Golconda itself never produced diamonds, and that it was in fact merely the mart where diamonds were bought and sold.

The name originally applied to the capital, now represented by a deserted fort in the neighbourhood of Haidrabad, was extended to the surrounding district, and seems to have been used for the whole kingdom,* which included many of the diamond localities, and in this way the popular belief on the subject arose; but Golconda Fort, it should be remembered, is many miles distant from the nearest of these.

At the present day there is a totally distinct tract of hilly country lying to the north of the Godaveri river, which also bears the name Golconda; whether it at any time formed a portion of the ancient kingdom I cannot say, but it is not, I believe, at present included in the territories of the Nizam o Haidrabad.

The districts included in this southern tract in the

* "Golconda is the most famous of the six independent Moslem kingdoms which, in A.D. 1399, rose on the extinction of the Toghlak (Delhi) dynasty, and it survived till 1688, when Aurungzebe brought all India under one sceptre."—Captain BURTON, *Quarterly Journal of Science*, N.S. vol. vi. 1876.

Madras Presidency in which there are or have been diamond mines are the following:—Kadapah, Karnul, Kistna, and Godaveri?

Proceeding northwards, the next locality at which there were mines was at Bhadrachellum on the Godaveri.

The second great tract occupies a considerable area between the Mahanadi and Godaveri rivers. Although diamonds are known but from two neighbourhoods within it, still, from our present knowledge of their geology, to which I shall presently allude, it is not improbable that the diamond-bearing strata may have a wide range. The two neighbourhoods referred to are Sambalpur, with the bed of the Mahanadi for many miles above it, and Weiragurh or Weiragud, eighty miles to the south-east of Nagpur.

Again, as an outlier to this second tract, there are two or three localities within the province of Chutia Nagpur where diamonds are known to have been found.

The third great tract is situated in Bandelkhand. near the capital of which, Panna, some of the principal mines are situated; but there are others scattered about in various parts of that province or kingdom.

Some authorities make allusion to a discovery of diamonds in the bed of the Ganges, but I have failed to trace this statement to its source, and I am not in possession of any particulars.

Lastly, about ten years ago some small diamonds, stated to have been found in a hill-stream near Simla, were forwarded by Sir E. C. Bayley to the Geological Museum at Calcutta.

Geology.

Although in the following pages I shall, for each locality, give a sketch of the mode of occurrence of the diamonds, it will be well, perhaps, by way of introduction, to give a general account of the formations which include the diamond-bearing beds, and likewise attempt to correlate those of the several localities respectively.

Up to the year 1855 Indian geology was in a condition of extreme confusion, for although much excellent work had been done, chiefly by amateurs, still it was, from the nature of the case, of a scattered and disjointed character, and the attempts at correlation of deposits situated at wide intervals had led to very erroneous conclusions, none of which were further from the truth, as now known, than those having reference to the diamond-bearing deposits.

In the year 1857 a collection of geological papers on Western India, &c., with a summary of the geology of India generally, were printed by the Government, under the editorship of Dr. Henry J. Carter. Valuable as this publication was, its day is now gone by, and it is, therefore, to be regretted that it should still continue to be quoted, not only by discursive writers on India, but even in standard works on general geology.

The publications of the Geological Survey of India, as now constituted, which commenced to appear more than twenty years ago, have from time to time for different areas successively replaced the confusion and incorrect correlation by an orderly arrangement based upon solid evidence. Erroneous conjectures

and unsound hypotheses have been overturned by work of that kind, which, especially in a country like India, can only be accomplished by professionals, whose whole time can be devoted to the subject, and whose operations are systematized under the leadership of one central authority.

The issue of the "Manual of the Geology of India" last year places the work of the Survey and our present knowledge of Indian geology in a more accessible and condensed form than it possessed when scattered through the now voluminous publications of the Survey. It is to be hoped that writers of geological text books will in the future refer to it for their facts rather than to the old sources of information, and that we shall never again see the "diamond sandstone," so called, classed as an Indian representative of the European Oolite.

Among the authorities quoted by Dr. Carter in reference to the diamond-bearing strata, the following are the principal:—Heyne, Jacquemont, Franklin, Voysey, and Newbold.

Some of these, especially Heyne, maintained that the diamond occurred only in a superficial recent conglomerate, formed of a great variety of fragments of the surrounding rocks, and resting indiscriminately on old rocks of different ages. Others recognized that in some cases the matrix of the gem was a conglomerate, which was a member of the clay slate formation, so called. This "clay slate formation," which included sandstones and limestones, and all their varieties now embraced in the Vindhyan formation, were considered to be the altered representatives of the Oolite, this being the age assigned to the coal-measures and associated plant and reptilian fossil-bearing sand-

stones. The latter were in fact held to constitute the unaltered portion of the rocks of the same period. The work of the Survey has demonstrated that this clay slate, or diamond sandstone, or Vindhyan formation, is separated by a wide break in time from the fossil-bearing rocks, being itself, so far as is known, absolutely azoic, and occupying a position in the geological sequence which may range from Lower Silurian to Carboniferous.

Further reference to the fossiliferous rocks will therefore be unnecessary here.*

Dr. Carter arrived at the conclusion that the diamond-bearing conglomerates, described by various authorities, occurred at least in the neighbourhood of, if they did not constitute members of, the Oolite formation. If for Oolite the term Vindhyan be substituted, the conclusion is probably in the main correct, and borne out by the most recent researches. But these researches have demonstrated that the principal diamond-bearing strata of the northern and southern areas respectively occupy distinct horizons, in those cases where the beds are not merely recent or sub-recent accumulations of débris.

It is due to Captain Newbold to say that he disagreed with the conclusions of many of the previous authorities, and he appears to have been inclined to regard the "sandstones" as being of Devonian age—a supposition probably not very far from the truth.

The Vindhyan rocks of Northern India are separated into two formations or sets of groups, distinguished as Upper and Lower.

* They will be found described in the chapter on "Coal."

In Southern India, and possibly also in the Central Mahanadi-Godaveri tract, it is considered that the lower set of groups is alone represented, and the two have been correlated as follows:—

On the southern rocks the local title of Karnul formation has been conferred.

	Northern India.	Madras.
	Vindhyan Formation.	*Karnul Formation.*
Upper.	Bhanrer Group.	
	Rewah ,, (*diamonds*).	
	Kaimur ,,	
Lower.	Tirhowan Limestones	=Khundair Shales and Limestones.
	Palkoa Shales	
	Dalchipur Sandstones	=Paneum Quartzites.
	Semri Shales and Limestone	=Jamalmadgu Shales and Limestone.
	Semri Sandstone	=Banaganpilly Sandstone (*diamonds*).

At Panna, in Bandelkhand, diamonds are only known certainly to occur *in situ* in a conglomerate which is referred to the Rewah group. There are, however, as elsewhere, numerous workings in alluvial or superficial deposits; but the greatest amount of labour is spent in mining in this the bottom bed of the group, which, though it has a wide extension, has only as yet been ascertained to be diamond-bearing in the neighbourhood of Panna. Although diamonds have not been obtained directly from any lower group, it would appear that this conglomerate is largely made up of pebbles derived from the lowest or Semri sandstone group, and since it is stated* that

* Mr. Medlicott, from whom I quote, states that this needs confirmation. The statement was made to him by a native miner.—*Manual*, p. 92.

diamonds are sometimes found in these pebbles when broken up, it would seem that the latter must include an earlier if not the original matrix of the gem. This point is of great interest, since it brings us to a horizon, the base of the formation, which is strictly comparable with that of the Banaganpilly group, which includes the lowest known matrix in Southern India. The order of succession of the rocks in the Mahanadi-Godaveri tract has not yet been ascertained; but from the fact of the only known localities where the diamond occurs being situated on the margin of the area, it may with a considerable degree of probability be assumed (notwithstanding possibly faulted boundaries) that the matrix is in a bed close to the base of the formation.

With regard to the minor areas, the Bhadrachelum diamonds may perhaps have been derived from some of the Karnul or Vindhyan rocks in the neighbourhood of the Godaveri.

The geology of the Chutia Nagpur localities is not yet known, but it is probable that in their vicinity an outlier of the Mahanadi-Godaveri rocks may exist.

The Simla diamonds, if the find be authentic, are of considerable interest, for although, as has been shown, diamonds *per se* do not afford evidence sufficient for exact correlation, still when it is remembered that according to some authorities the older Palæozoic rocks of the Himalayas present many points of resemblance with those of the Peninsula, the possibility of the matrix containing these diamonds being on a horizon comparable to that in the Banaganpilly group of the Karnul (L. Silurian?) formation cannot fail to suggest itself.

As particulars regarding the exact *locale* whence the

diamonds were brought is not available, it would be useless to enter further here into any account of the geology of the neighbourhood of Simla.

Mr. Griesbach, of the Geological Survey of India, has recently published some interesting remarks upon the correlation of the Vindhyan rocks of India with certain series occurring in South Africa, to one of which the sandstones of the Table Mountain belong. The possibility of the Cape diamonds, therefore, belonging to a period or horizon directly comparable to that which includes the Indian diamonds, offers itself as a subject worthy of future investigation. A comparison of the geology of Borneo with that of India may also prove productive of interesting results in this respect.

But the incorrect conclusions of the earlier writers, drawn from imperfect data, which I have noticed above, as to the age of the diamond-bearing strata in India, afford a sufficient warning of the danger of premature attempts at correlation.

Origin of the Diamond.

The examination of the diamond-bearing strata of India has not resulted, so far as I know, in throwing any definite light on the yet unsettled question as to the conditions under which the crystallization of carbon took place, thus forming the precious gem which has occupied so important a position in history. Light regarding the subject seems to be destined to reach us, indeed, from another quarter, and it is to the synthetical operations of the laboratory, which, it is needless to point out, have made such great

advances in this direction of late years, that we must look for the true explanation.

But the absence of any clear evidence on the subject may be due to the fact that it is still a matter of doubt whether, in any single recorded case in India, a diamond has been found in its original matrix. The lowest diamond-bearing stratum, at the base of the Karnul series, is itself a detrital conglomerate, and it is not unreasonable to suppose that the diamonds may, like the other ingredients, have been derived from some older metamorphosed rocks.

Mr. King* discusses some apparent cases of mines in the Kadapah series of rocks which underlie the Karnuls, but he says there is "still a doubt as to whether true rock-workings in these beds were ever successful."

Elsewhere, *l.c.*, p. 101, however, he states of the diamonds shown to him at Banaganpilly that—

> Nearly all the specimens were more or less perfect modifications of the octahedron, with curved facets; one of them had each of its facets crowned with a little pyramid of tables.†
>
> They were smooth, tolerably bright and shining, and did not look as if they had been worn; in fact, they seemed to me to have been crystals *in situ* in the rock. In colour they were pale blue, or green and yellow.

Captain Newbold, in discussing this subject, without much difficulty disposes of Captain Franklin's suggestion that the beds containing the diamonds of

* "Memoirs of the Geological Survey of India," vol. viii. p. 88.

† Newbold speaks of the diamonds shown to him at the same locality as being "but imperfectly crystallized."—*J. R. A. S.* vol. vii.

Panna may have been roasted by the ignition of coal seams, which, he believed, existed below. He then remarks:—"It is fully proved, I think, from the experiments of Sir David Brewster, that the diamond has once been in a soft state, like amber, opal, or the tabashir. Minute cavities, surrounded by a compressed structure analogous to those in the Laske diamond, are seen in several specimens of the Indian gem which have been brought me by the diamond merchants." He appears to be disposed to favour the native idea that the diamond is reproduced in the soil. "The old miners stated to me that a term of fifteen or twenty years was requisite for the reproduction of the gem." They were in this belief led to re-wash old tailings, and accounted for the fact of the diamonds found in them being so small by saying that they had not had time to grow larger. The same idea was favoured by Dr. Heyne. An unbeliever in this hypothesis would be inclined to suggest that the smallness of the diamonds accounted for their having eluded the searchers in the first washings. Indeed, Franklin mentions that some of the miners he spoke to said that diamonds escaped notice in the first washings owing to their being encrusted with dirt.

KADAPAH, OR CUDDAPAH, DISTRICT.

Within the limits of the Kadapah district the principal localities where diamonds have been worked for are, according to Mr. King, Cunnapurtee and Woblapully, or Obalumpally, near Chennur, on opposite banks of the Pennair river and Lamdur and Pinchetgapadu, west of Chennur.

These mines are generally by authors referred to under the title

CHENNUR, OR CHINON.

This is a village near Kadapah town, where there are deserted pits, which were sunk in gravels, derived from the disintegration of the Banaganpilly quartzites, and lying below the black cotton soil (or regur). These have recently been reopened by a Mr. Richardson, of Madras, who applied to the Collector of Kadapah for permission to work the mines in 1869, at the favourable rent of 100 rupees per annum. The result has not been successful, but there are accounts of two diamonds having formerly come out of this field which were eventually sold for 5,000 and 3,000 rupees each.*

CUNNAPURTEE, OR CONDAPETTA.

This locality appears to be identical with the Condapetta of Captain Newbold, whose detailed account is, perhaps, of sufficient interest to be quoted *in extenso*. He says:†—

At Condapetta the mines are generally of a square form, and from four to twelve feet deep. The stratum cut through is of cotton soil, mixed with small grains of quartz, generally from three to ten feet thick, which rests immediately on a bed of rolled stones of various sizes, from that of a paving-stone to a nut, in which the diamonds are found, generally loose, but sometimes adherent. The stones are mingled with mud and gravel. The pebbles most commonly met with are ferruginous, gritty, and schistose sandstones, sandstone conglomerates,

* King, "Records Geological Survey," vol. ii. p. 9; and "Memoirs Geological Survey," vol. viii. p. 106.

† *J. R. A. S.* vol. vii. p. 226.

embedding rolled pebbles of quartz, chert, and jasper; claystone porphyry, with crystals of felspar; blue jasper, veined with oxide of iron; coarse red jasper, and quartz crystals. Some of these pebbles have evidently been transported from the adjacent hills, but the porphyritic and felspathic pebbles must have travelled a much greater distance. Near the base of the hills the cotton soil is covered with red gritty earth, arising from the disintegration of the sandstone rock.

The process of mining consists merely in digging out the rolled pebbles and gravel, and carrying them to small square reservoirs raised on mounds, having their bottom paved with stones, and washing them carefully. At the foot of the mound is a clear space surrounded by heaps of refuse, where the washed gravel is again carefully spread out and examined in presence of the diamond contractors; the diamonds are easily recognized in the moist state by their peculiar lustre. These mines are let out by the Government to native contractors, who gave me the following information on the spot. In 1834 the mines proved profitable, but in the following year the miners lost a considerable sum. The sum paid to Government by them for the privilege of mining a piece of ground 100 yards long by 50 broad, for four months, is 200* rupees.

Dry weather is selected to carry on operations to avoid the inconvenience and expense of draining. In former days all the diamonds produced were carried for sale to Golconda. In those times very large diamonds were found; but subsequent to British ascendency—which according to the superstitious natives is by no means pleasing to the tutelary deities of the mines—few of any

* In 1840, the contract rose to about 250 rupees. When a diamond of more than a gold pagoda in weight (= 52·56 grains at Madras) is found it is sold by public auction, and one-third of the proceeds goes to Government, the remainder to the mining contractor.

value have been found, probably in consequence of their being less looked after. However, lately in 1839, a fine diamond of the Kshatriya or roseate caste was dug from the Obalumpally mine, exceeding a gold pagoda in weight, which was sold for 1,450 rupees.

KARNUL DISTRICT.

Mr. King's list of diamond localities in the Karnul District* is as follows :—

BANAGANPILLY .	37 miles S.S.E. of Karnul. Rock workings. Worked.
MUNIMUDAGU .	16 miles W. by S. of Banaganpilly. Rock workings. Deserted.
RAMULKOTA . .	18 miles W. by S. of Karnul. Alluvial washings. Worked. Rock workings deserted.
TIMAPOORAM. .	6 miles E.S.E. of Ramulkota. Rock workings. Deserted.
YEMBYE	24 miles S.S.E. of Karnul. Rock workings. Deserted. (Capt. J. G. Russell, *teste*.)
BYANPULLY . .	
GOORAMANCONDA .	
GOODYPAUD . .	Nundycotkoor talug. Doubtful localities. (Capt. J. G. Russell, *teste*.)
BANNOOR . . .	
DEVANOOR . . .	
SHAITANCOTAH .	Right Bank of Toongabudra, E.N.E. of Karnul. Deserted.
DEOMURROOH . .	Left bank of Toongabudra. Deserted.
TANDRAPAD . .	,, ,, Alluvial. Deserted.
BUSSWAPOOR . .	Nullamullays. Rock workings and alluvial washings. Deserted.

BANAGANPILLY.

The diamond mines at this locality have been visited and described by many writers. Heyne, Newbold,

* "Memoirs of the Geological Survey of India," vol. vii. p. 106.

Malcolmson, and Voysey, have all left on record accounts of them.

Mr. King's already mentioned report containing the latest and most authentic account of them, it will be best, perhaps, to quote from it a few passages verbatim, at the same time stating that Mr. King refers those who are likely to be specially interested to Dr. Heyne, for an account of the mines as they appeared in his day.

Mr. King writes :—

The quartzites of the Banaganpilly group form a cap, resting uncomformably on the denuded surface of a much older set of shales and traps with some limestone bands. . . . . The quartzite covering is from 20 to 30 feet in thickness; and it is pierced here and there over the Banaganpilly end of the hill, by shafts of 15 feet or less, from the bottoms of which nearly horizontal galleries are run to get at the seams of diamond gangue. The capping is composed of compact grits and sandstones in thickish beds above, and somewhat thinner bedded towards the bottom.

Externally the rocks are hard and vitreous. At the level of the galleries there are *beds of coarse pebbly conglomerate, occasionally a breccia,* which are sandy and clayey, and with these run seams of more shaley and clayey stuff. There is no trace of the clayey constitution on the outside along the outcrop, nor are there any distinct bands of shales; there are only some sandy shales down at or near the bottom of the series. . . . .

In the mines the coolies were picking out a seam of about six or eight inches in thickness, occurring with thicker and harder beds of sandstone, and which they said was the diamond layer; this rock when brought to light turned out to be an easily broken up damp clayey conglomerate and partly breccia, of small rounded fragments and pebbles of black, red, green, and pale-coloured shales and cherts, and of quartzite with large and small

grains of dirty and pellucid quartz. This was the rock extracted in all the mines then being worked. The gangue is then pounded up, washed, sifted and laid out to dry on prepared floors, after which the residue of clean sand is carefully examined in the hand, by the women and children of the working parties, for the precious gems. I saw no diamonds *in situ*, nor did I see or hear of any diamond being found during my stay at Banaganpilly for four or five days at a time. Diamonds were brought to me which were reported to have been found in the mines; but these were most disappointing in their minuteness, flaws, and dirty colours.

I have already quoted Mr. King above as to the crystalline forms of these samples.

He says that the good specimens were valued at only ten rupees by the merchants. But one specimen, said to have come from the Bellary district, but which, he thought, had probably been found on the spot, was valued at 350 rupees.

Neither the Nawab of Banaganpilly nor his followers, nor the Tehsildar of the place, nor the merchants, could, or would, tell me of any better diamonds having been found for many years.

Mr. King tracked the diamond-bearing strata for some miles westward beyond the region wherein it is worked.

Munimudagu.

In the neighbourhood of Munimudagu, sixteen miles west-by-south of Banaganpilly, there is a continuation of the diamond-bearing strata, which cover the older Kadapah rocks as with a thin skin. The locality is described both by Mr. King and Captain Newbold. The mines have long been deserted, but, according to the last-named authority, there was in his time a colony of diamond polishers in the town.

RAMULKOTA.

The position of these mines is variously stated as being from eighteen to twenty-one miles from Karnul, in a southerly direction. They are also described by Mr. King and Captain Newbold.

They are now merely alluvial washings in the débris of the Banaganpilly group, but formerly there were regular mines. Captain Newbold says :—

The pits, though not occupying so large a superficies, are deeper and far more extensive than those near Kadapah ; the old excavations in the rocks resemble those of Banaganpilly and Moonimudagu. The diamonds that were shown me here, one in the parent rock, the conglomerate, were of an inferior size and but few crystallized in the octohedral form. They had severally white, grey, yellow and greenish tints, but it was told me that those found in the conglomerate rock are generally of a superior description, with a fine roseate tinge.

Mining and washing was carried on as at Kadapah. There were 300 natives at work in the wet season, but only 20 when visited by Newbold.

The contractors leased the mines for 750 rupees from the Nawab of Karnul, and sublet to minor speculators.

The hire of a labourer was four pice—or about three halfpence—and a meal of rice *per diem*.

RAOLCONDA.

This was the first mine visited and described by Tavernier,* who stated that it was in the Karnatic, five days' journey from Golconda and eight or nine from Visapour.

* "Travels," Book II. pt. ii. chap. xii. "Of Diamonds and the Mines and Rivers where they are found, and first of the Author's Journey to the Mine of Raolconda."

Since, however, he elsewhere gives a list of nine stages between this locality and Golconda, the aggregate distance being 68 French leagues, or, say, 189 English miles, I was at first inclined to believe that the distances from Visapour and Golconda had been transposed. This being admitted, there was no difficulty in identifying Raolconda with the modern Rawduconda, in Lat. 15° 41′, Long. 76° 50′ in the Nizam of Haidrabad's territory. But after consultation with Mr. King, I now think that the place must have been near to, if not identical with, Ramulkota. Tavernier says:—

The strata containing the diamonds ranged from half an inch to an inch in thickness, and the gangue was hooked out with iron rods. Some of the stones were valued at from two to sixteen thousand crowns. The steel wheel was used for cutting.*

Tavernier gives an account of the polishing of the gems as practised here. His account of the great security of property and system, with reference to the sale of diamonds, together with the courtesy with which he was treated, will be read generally with interest.

Kistna and Godaveri Districts.

The principal mines in these districts are situated on the banks of the Kistna, or Krishna. They are named Golapilly, Malavilly, Purtial, Gani-Coulour = Kollur, &c.

* Quoted from Capt. Burton, "Quarterly Journal of Science," N.S., vol. vi. 1876.

GOLAPILLY.

The diamond pits at this locality, according to Mr. King, were sunk in conglomerates and pebble beds of tertiary age* (Rajahmundry sandstone group). Mr. Blanford† says that the

> Diggings appear not to have been in the sandstone itself, but in the very gravelly laterite which rests upon the sandstone, but the surface is so much broken and altered by the pits that it is difficult to say. The workings cover a very considerable area.

At the time of Mr. Blanford's visit (1871) these mines had the appearance of having been long abandoned, being covered with bush jungle.

Dr. Heyne (Tracts) stated that

> In the Ellore district the diamond stratum is covered by a thick stratum of calcareous trap.

This does not appear to have been confirmed by any subsequent writer, and is apparently a mistake. The thickness of the conglomerate is said to be from two to six feet thick, perhaps more in some places.

MULAILY, OR MALAVILLY, N.E. OF BEZWARRA.

As at Golapilly, the mines here also were in tertiary conglomerates (King). Captain Newbold‡ describes the bed of gravel in which the pits were sunk as being "composed chiefly of rolled pebbles of quartz sandstone, chert, ferruginous jasper, conglomerate sandstone, and *kankar*, lying in a stratum of dark mould about a foot thick." He appears, according to Mr.

* "Records of the Geological Survey of India," vol. x. p. 58.

† *Idem*, vol. v. p. 27.

‡ Geological Notes, p. 67 of Carter's "Collection of Geological Papers."

King, to have been wrong in identifying this deposit, which rests on gneiss, with the true old diamond conglomerate of Banaganpilly, of which it should, therefore, not be regarded as an outlier—though, doubtless, there is some similarity in the component pebbles, &c., which form both rocks.

Dr. Benza believed the conglomerate to be continuous from hence through Ellore and Rajahmundry to Samulcotah, where also diamonds are said to have been found.

Purtial or Purteeali.

The mines so called are situated near a village of the same name, which is not far from

Kondapilly, about 150 miles from Haidrabad, on the road to Masulipatam. The property of them was reserved by the late Nizam when he ceded the northern circars to the English Government. They are superficial, not extending ten or twelve feet deep in any part. For some years past the working of them has been discontinued.

Mr. Briggs, the author of the above, who is quoted by Captain Burton,* adds :—

And there is no tradition of their ever having produced very valuable stones.

Captain Burton remarks upon the statement that it is full of error, as the Pitt or Regent diamond came from Purtial, but Captain Newbold says it came from Borneo, being bought by Mr. Pitt, from a merchant of Bencoolen, in Sumatra.

Regarding the origin of these diamonds from the various localities bordering the Kistna river, near Kondapilly, Captain Newbold expresses his belief that the materials of the beds were brought down

* "Quarterly Journal of Science," N.S., vol. vi. 1876.

from the hills of sandstone and limestone through which the river has recently passed, and Voysey remarks the persistency of the same kind of conglomerate at all the mines.

GANI-COULOUR = THE MODERN KOLLUR.*

This locality appears to be identical with Kollur, 24 miles west of Purtial on the Kistna. Tavernier's route, a seven days' journey eastwards from Golconda, can be traced on modern maps and several of the stages identified. On the last day he crossed a river (the Kistna) and found himself at the mines.

Capt. Burton (l.c.) appears, therefore, to have been misled when he placed Gani-Coulour on the Bhima, to the west of Golconda.

Tavernier's account of the mine at this locality is as follows†:—

> It is not above a hundred years since this mine was discovered by a countryman, who, digging in a piece of ground to sow millet, found therein a pointed stone that weighed above twenty-five carats. He, not knowing what the stone was, but seeing it glisten, carried it to Golconda, where, as it happened well for him, he met with one that traded in diamonds. The merchant informing himself of the place where the stone was found, admired to see a jewel of that bigness, not having seen before one that weighed ten or twelve carats. However, his report made a great noise in the country, inasmuch that the moneyed men in the town set themselves to work, and causing the ground to be searched they found, and still do find, bigger stones and in greater quantity than in any other mine, for

* Written *Garree* by Dieulafait, "Diamonds and Precious Stones." London: Blackie. 1874. *Gani* is, however, merely a prefix meaning *Kan-i* or "mine of."

† "Travels," chap. xii.

they found a great number of stones from ten to forty carats, and sometimes bigger, among the rest that large stone that weighed 900 carats, which Mirimgola presented to Aurengzeb.*

After the miners have pitched upon the place where they intend to work they level another place close by, of the same extent, or else a little bigger, which they enclose with a wall about two feet high. In the bottom of that little wall, at the distance of every two feet, they make small holes to let in the water, which they stop up afterwards till they come to drain out the water again. The place being prepared the people that are to work meet all together, men, women, and children, with the workmaster in the company of his friends and relations. Then he brings along with him some little image of the god that they adore.

After worship of this and a feast of rice, Tavernier continues :—

When the feast is over the men fall to digging, the women and children to carry earth to the place prepared in that manner as I have already described. They dig ten, twelve, and sometimes fourteen feet deep, but when they come to any water they leave off.

All the earth being carried into the place before mentioned, the men, women, and children throw the water which is in the drains upon the earth, letting it soak for two or three days according to the hardness of it, till it comes to be a kind of batter, then they open the holes in the wall to let out the water and throw on more water still, till all the mud be washed away and nothing left but the sand. After that they dry it in the sun, and then they winnow the sand in little winnows as we winnow our corn.

. . . . The earth being thus winnowed, they spread it with a kind of rake, as thin as they possibly can ; then

* This by some authorities is thought to have been the Koh-i-nur. If so it was found about the year 1550.

with a wooden instrument, like a paviour's rammer, about half a foot wide at the bottom, they pound the earth from one end to the other two or three times over. After that they winnow it again then, and spreading it at one end of the van, for fear of losing any of the earth, they look for the diamonds. Formerly they were wont to pound the earth with great flintstones instead of wooden rammers, which made great flaws in the diamonds, and is, therefore, now left off.

The first time I was at the mine there were about 60,000 persons at work—men, women, and children; the men being employed to dig, the women and children to carry the earth.

Central Province or Mahanadi-Godaveri Tract. Sambalpur.

In Ptolemy's map* the Adamas river flows into the Gangeticus sinus (Bay of Bengal), midway between Cosamba on the north (Balasore?) and Cocala (Sicacole of Arrowsmith's map, the modern Chicacole). The Dosaron and Tyndis rivers probably represent the Godaveri and Kistna, so that it is very likely that the Adamas may safely be identified with the Mahanadi. Ptolemy represents the Adamas as flowing through the district of Sabaræ, across which runs the following description: *Apud quos adamas est in copia*, which is otherwise given in an earlier edition of the map.† *Sabaræ i his habundat Adamas.* [In Sabaræ the diamond occurs in abundance.] The upper portion of the river passes through a district named Cocconage, which would include Chutia Nagpur.

* Asiæ, x. tab. "Geographiæ," libri octo, Gr. et Lat. Opera P. Bertii Lugduni. Bat. 1618. Fol.

† Tab. x. "Cosmographiæ," libri viii. Lat. Justi di Albano, Ulmae. 1486. Fol.

The first visit to the latter region by a European of which I have been able to find a record was made by the already-mentioned French jeweller Tavernier,* who appears to have gone there somewhere about 1665. He says:—

I come to the third mine, which is the most ancient of all, in the kingdom of Bengala. You may give it the name of Soumelpour, which is the name of the town next to the place where diamonds are found, or rather Gouel, which is the name of the river in the sand whereof they seek for the stones. The territories through which this river runs belong to a Raja who was anciently tributary to the Great Mogul, but revolted in the time of Sha Jehan and Gehan Guir, his father. So soon as Sha Jehan came to the empire he sent to demand his tribute of this Raja, as well for the time past as to come, who, finding that his revenues were not sufficient to pay him, quitted his country, and retired into the mountains with his subjects. Upon his refusal, Sha Jehan, believing he would stand it out, sent a great army against him, persuading himself that he should find great store of diamonds in his country. But he found neither diamonds, nor people, nor victuals—the Raja having burnt all the corn which his people could not carry away, so that the greatest part of Sha Jehan's army perished for hunger. At length the Raja returned into his country, upon condition to pay the Mogul some slight tribute.

Then follows an account of the route travelled over by Tavernier from Agra, *viâ* Allahabad and Rhotas, to Soumelpour. He continues:—

Soumelpour is a great town, the houses whereof are built of earth, and covered only with branches of coco† trees.

* "Travels." London. 1678. Book ii. chap. xiii. p. 139.

† Probably the leaves of the *Tal* palm. The cocoa-nut does not occur there at present. Elsewhere, however, it has been found at as great a distance from the sea.

All these 30 leagues (*i.e.*, from Rhotas to Soumelpour) you travel through woods, which is a very dangerous passage, as being very much pestered with robbers.

The Raja lives half a league from the town, in tents set upon a fair rising ground, at the foot whereof runs the Gouel, descending from the southern mountains, and falling into the Ganges.

In this river they find the diamonds. For after the great rains are over, which is usually in December, they stay all January till the river be clear, by reason that by that time in some places it is not above two feet deep, and in several places the sand lies above the water.

About the end of January or the beginning of February, there flock together out of the great town, and some others adjoining, about eight thousand persons, men, women, and children, that are able to work. They that are skilful know by the sand whether there be any diamonds or no, when they find among the sand little stones like to those we call "thunderstones." They begin to make search in the river from the town of Soumelpour to the very mountains from whence the river falls for fifty leagues together.

Where they believe there are diamonds, they encompass the place with stakes, faggots and earth, as when they go about to make the arch of a bridge, to drain all the water out of that place. Then they dig out all the sand for two feet deep, which is all carried and spread upon a great place for that purpose prepared upon the side of the river, encompassed with a little wall about a foot-and-a half high.

When they have filled this place with as much sand as they think convenient, they throw water upon it, wash it, and sift it, doing in other things as they do at the mines, which I have above described.

From this river come all those fair points which are called natural points; but a great stone is seldom found here. The reason why none of these stones have been seen in Europe, is because of the wars that have hindered the people from working.

An ingenious suggestion by Karl Ritter (*Erdkunde Asien*) has led me to inquire into the identity of Soumelpour of Tavernier with the modern Sambalpur. There can be little doubt that they are not identical. The Gouel river, which runs into the Ganges, is doubtless the Koel, and, according to Tavernier's indication, Soumelpour must have been in the district of Palamow, in Chutia Nagpur. Perhaps the present town of Semah marks the spot.

The first visit of importance to the true Sambalpur on the Mahanadi is described in the narrative of a journey which was undertaken by Mr. Motte in the year 1766.* The object of this journey was to initiate a regular trade in diamonds with Sambalpur, Lord Clive being desirous of employing them as a convenient means of remitting money to England. His attention had been drawn to Sambalpur by the fact that the Raja had, a few months previously, sent a messenger, with a rough diamond weighing 16½ carats as a sample, together with an invitation to the Governor to depute a trustworthy person to purchase diamonds regularly. The Governor proposed to Mr. Motte to make the speculation a joint concern, "in which," writes the latter, "I was to hold a third; he the other two; all the expenses to be borne by the concern. The proposal dazzled me; and I caught at it, without reflecting on the difficulties of the march, or on the barbarity of the country," &c.

In spite of his life being several times in danger from attacks by the natives, the loss of some of his followers by fever, and a varied chapter of other disasters, Mr. Motte was enabled to collect a considerable amount of interesting information about the country. Owing to the disturbed state of Sambalpur

* "Asiatic Annual Register." London. 1799.

town, however, he was only able to purchase a few diamonds. After much prolonged negotiation, he was permitted to visit the junction of the rivers Hebe (Ebe) and Mahanadi, where the diamonds were said to be found. A servant of the Raja's, who was in charge there, informed him that "it was his business to search in the river Hebe, after the rains, for red earth, washed down from the mountains, in which earth diamonds were always found. I asked him if it would not be better to go to the mountains and dig for that earth. He answered that it had been done, until the Maharattas exacted a tribute from the country; and to do so now would only increase that tribute. He showed me several heaps of the red earth—some pieces of the size of small pebbles, and so on, till it resembles coarse brick-dust—which had been washed and the diamonds taken out."*

Mr. Voysey, on his last journey from Nagpur to Calcutta, in 1824, visited the diamond washings of Sambalpur. He mentioned that the gems were

> Sought for in the sand and gravel of the river—the latter consisting of pebbles of clay slate, flinty slate, jasper, and jaspery ironstone of all sizes, from an inch to a foot in diameter.†

The next mention of Sambalpur diamonds is to be found in Lieutenant Kittoe's account‡ of his journey,

* This description suggests laterite as the matrix from which the diamonds were proximately derived. Messrs. Hislop and Hunter, *vide infra*, describe the diamonds of Weiragurh as occurring in laterite gravel. In this connexion it may be noted that one of the sources of Cape diamonds is said to be a superficial ferruginous conglomerate.

† *Vide* Carter's "Summary of the Geology of India," p. 724.

‡ "Journal Asiatic Society, Bengal," vol. viii. p. 375. 1839.

in the year 1838, through the forests of Orissa. He speaks of the people as being too apathetic and indolent to search for diamonds. His remarks on the localities where they occur seem to be derived from Mr. Motte's account, to which, indeed, he refers.

Although published in the same number of the Asiatic Society's Journal,* we find a Paper, dated two years later, or 1840, which was written by Major Ouseley, on the "Process of Washing for Gold-dust and Diamonds at Heera Khoond." In this we meet the following statement:—

> The Heera Khoond is that part of the river which runs south of the islands. The diamonds and gold-dust are said to be washed down the Ebe River, about four miles above the Heera Khoond; but as both are procurable as far as Sonpur, I am inclined to think there may be veins of gold along the Mahanadi.

The occurrence of diamonds in the river so far below Sambalpur as Sonpur must have been very exceptional. No mention is made by Major Ouseley of the system of throwing an embankment across one of the channels, which is described below; but from my inquiries I gathered that that method of washing was in practice for many years before the period of Major Ouseley's visit. He describes the operations of individual washers—not the combined efforts of the large number—which made that washing successful. The diamonds found became the property of the Raja, while the gold was the perquisite of the washers, who sold it for from twelve to fifteen rupees a *tola*.

Captain Newbold says,† that "diamonds of considerable value are also found in the bed and alluvium

* "Journal Asiatic Society, Bengal," vol. viii. p. 1057. 1839.

† "Jour. Roy. Asiatic Society," vol. vii.

of the Mahanadi River, especially at Sambalpur, and about the mouths of the Hebe, Khelu, and Mand streams, but their beds have not hitherto, I believe, been traced." Captain Burton mentions* that, according to some authority not named, the Majnodi, a tributary of the Mahanadi, contained diamonds.

In the *Central Provinces Gazetteer* it is stated that:

> During the period of native rule some fifteen or twenty villages were granted rent-free to a class called *Jhiras*, in consideration of their undertaking the search for diamonds. When the country lapsed in 1850, these villages were resumed.

So far as can be gathered from the various sources of information, large and valuable diamonds have been occasionally met with; but the evidence on this point is somewhat conflicting. I do not think, however, that what we know is altogether consistent with the statement in the *Gazetteer*, that "the best stones ever found here were thin and flat, with flaws in them."

Local tradition speaks of one large diamond, which was found during the Maharatta occupation. Its size made its discovery too notorious; otherwise it would, in all probability, like many other smaller ones found at that time, never have reached the hands of the Maharatta agent. It is said to have weighed two tolas and two mashas (at ten mashas to the tola)† which would be about 316·2 grains troy, or, expressed in carats, 99·3. It would be impossible, of course, to make any estimate of the value of a rough stone of this size, regarding the purity, colour, &c., of which

* "Quarterly Journal of Science," N.S., vol. vi. p. 351. 1876.

† (One masha = 14·37 grains troy): properly speaking there are 12 mashas in a standard tola.

nothing is known.* Another diamond, in the possession of Narain Singh, is said to have weighed about *a tola*, the equivalent of which, calculated as above, would be 45·35 carats. Already one of 16·5 carats has been mentioned as having been sent to Calcutta in 1766. One large but slightly flawed diamond, which I saw in the possession of a native in Sambalpur, was valued in Calcutta, after cutting, at Rs. 2,500. Mr. Emanuel, in his work on "Diamonds and Precious Stones," gives some particulars regarding the diamonds of Sambalpur. He records one diamond of 84 grains having been found within the period of British rule. There are said to be a good many diamonds still in the hands of the wealthier natives in Sambalpur. Of course, large diamonds such as those above mentioned, are of exceptional occurrence; those ordinarily found are said to have weighed, however, two to four rutties, equal on an average, say, to the thirtieth part of a tola, or 4·7 grains = 1·48 carats. In the Geological Museum at Calcutta there is at present a diamond which was sent to the Asiatic Society of Bengal, from Sambalpur, by Major Ouseley. It weighs only ·855 grains = ·26 carats.

As is usual, I believe, in all parts of India, the diamonds were classed as follows :—

1. *Brahman.*—White, pure water. 2. *Kshatrya*—Rose or reddish. 3. *Vasiya.*—Smoky. 4. *Sudra.*—Dark and impure.

Since the above was first published, as the result chiefly of local and personal inquiries, I have had an opportunity of consulting a work by Surgeon Breton,

* Tavernier's method of ascertaining the value of any diamond was to square the number of carats, and then multiply the result by the value of a one-carat stone of equal purity.

dated 1825,* which contains a considerable amount of interesting information in reference to Sambalpur diamonds. The following Table gives the history of the diamonds found between the years 1804 and 1818. The large diamond which fell into the hands of the Mahratta agent weighed 672 grains troy, not 316·2 as I was told by the washers; it is said to have been of the third, or Vasiya, quality. The 84-grain diamond was handed over to the British agent by the finder, in 1818. Its value was stated to be 5,000 rupees.

Weight.†					By whom received from finders.
Years.	No.	Mashas.	Rutties.	Grains Troy.	
?	1	20	4	288	Rani Ruttun Coher
1804	1	4	0	56	Do. Do.
1805	1	7	0	98	Do. Do.
1807	1	22		308	Do. Do.
1808	1	1		14	Do. Do.
1809	1	48		672	Chanderji Bhúnsla
,,	3	0	3½	7	Do. Do.
,,	1	1	0	14	Sacca Ram Gopál
1810	2	2½		35	Chanderji Bhúnsla
1811	1	4		56	Do. Do.
1813	1	2		28	Mahadeo Rae
1815	1	2		28	Do.
1816	1		6½	13	Do.
1817	1	2		28	Do.
,,	1		2	4	Do.
1818	1	6	0	84	Do.
,,	1	1	0	14	Do.

With regard to the origin of the Sambalpur diamonds, the geological structure of the country leaves but little

* "Medical Topography of the Districts of Chota Nagpur, Serguja and Sambhulpore, Calcutta." 1826.

† According to this Table the Sambalpur Masha = nearly 14 grains troy, and the Rutti a fraction under two grains.

room for doubt as to the source from whence they are derived. Coincident with their occurrence is that of a group of rocks, which has been shown to be referable to the Vindhyan series, certain members of which series are found in the vicinity of all the known diamond-yielding localities in India, and, in the cases of actual rock-working, are found to include the matrix of the gems.

In several of the previous accounts, the belief is either stated or implied that the diamonds are brought into the Mahanadi by its large tributary, the Ebe. It would not, of course, help the point I am endeavouring to establish as to their origin, to say that the Ebe, at least within our area, except indirectly,* is not fed by waters which pass over Vindhyan rocks, but I have the positive assurance of the natives that diamonds have not been found in that river, although gold is and has been regularly washed for. On the other hand, diamonds have been found in the bed of the Mahanadi as far west as Chanderpur, and at other intermediate places well within the area which is exclusively occupied by the quartzites, shales, and limestones of Vindhyan age.

The fact that the place, Hira Khund, where the diamonds were washed, is on metamorphic rocks, may be readily explained by the physical features of the ground. The rocky nature of the bed there, and the double channel caused by the island, afforded unusual facilities for, in the first place, the retention of the diamonds brought down by the river, and secondly, for the operations by which the bed could on one side

* By a few small streams which rise in an isolated outlying hill, called Gotwaki.

be laid bare, and the gravel washed by the simple contrivances known to the natives.

It is impossible to say at present which the actual bed or beds of rock may be from whence the diamonds have been derived, as there is no record or appearance of the rock ever having been worked; but from the general lithological resemblance of the sandstones and shales of the Barapahar hills and the outlier at Borla with the diamond-bearing beds, and their associates at Panna, in Bhandelkand, and Banaganpilly, in Karnul, I have very little hesitation in pointing to these rocks as, in all probability, including the matrix. Above Padampur, the Mahanadi runs through rocks of this age, and I should therefore strongly urge upon any one who may hereafter embark upon the undertaking of searching for diamonds in Sambalpur, to confine his operations, in the first instance, to the streams and small rivers which rise in the Barapahar hills and join the Mahanadi on the south. Besides the obvious advantage of being—as I believe would be found to be the case—close to the matrix, these streams would, I think, be found to contain facilities for obtaining a sufficient head of water for washing purposes. Such works would require but a few labourers, and could be carried on for a much longer period every year, say altogether for eight or nine months, than would be possible in the case of the washings in the bed of the Mahanadi itself.

According to the accounts received by me, the southern channel of the Mahanadi used not to be emptied in the Raja's time; but from various causes I should expect it to yield, proportionately, a larger number of diamonds than the northern. In the first place, the stronger current in it would be more efficient

in removing the substances of less specific gravity than diamonds, while the rocks and deep holes in it afford admirable means for the retention of the latter. Owing to the greater body of water to be dealt with, it would be found to be more difficult to divert than that which flows in the northern channel; but the result in a greater harvest of diamonds would probably far more than compensate for the greater expenditure incurred.

In the country to the south of Sambalpur, in Karial and Nowagarh, where rocks of similar age occur to those of the Barapahar hills, I have failed to find any traditional record of diamonds having ever been found or searched for. It is just possible, however, that the names of several villages in which the word *Hira* (diamond) occurs, may have reference to some long-forgotten discovery.

In addition to diamonds—pebbles of beryl, topaz, carbuncle, amethyst, cornelian, and clear quartz used to be collected in the Mahanadi; but I have not seen either sapphires or rubies. It is probable that the matrix of these, or most of them, exists in the metamorphic rocks, and is, therefore, distinct from that of the diamonds.

Method of Working.—From personal inquiry from the oldest of the Jharas, or washers, at the village of Jhunan, and from various other sources, I have gathered the following details as to the manner in which the operations were carried on in the Raja's time:—In the centre of the Mahanadi, near Jhunan, there is an island, called Hira Khund,* which is about four miles long, and for that distance separates the waters of the river into two channels. In each year, about the beginning of March or even later, when other work

* *Lit.*, diamond mine.

was slack and the level of the water was approaching its lowest, a large number of people—according to some of my informants, as many as 5,000—assembled and raised an embankment across the mouth of the northern channel, its share of water being thus deflected into the southern. In the stagnant pools left in the former sufficient water remained to enable the washers to wash the gravel accumulated between the rocks in their rude wooden trays and cradles. Upon women seems to have fallen the chief burden of the actual washing, while the men collected the stuff. The implements employed and the method of washing were similar to those commonly adopted in gold-washing, save only that the finer gravel was not thrown away until it had been thoroughly searched for diamonds—at least, I was given so to understand, but Tavernier's account of this part of the process is probably correct. Whatever gold was found became the property of the washer, as already stated. Those who were so fortunate as to find a valuable stone were rewarded by being given a village. According to some accounts, the washers generally held their villages and lands rent-free; but I think it most unlikely that all who were engaged in the operations should have done so. So far as I could gather, the people did not regard their (in a manner) enforced services as involving any great hardship; they gave me to understand that they would be glad to see the annual search re-established on the old terms. Indeed, it is barely possible to conceive of the condition of the Jharas having been at any time worse than it is at present. No doubt the gambling element, which may be said to have been ever present in work of the above nature, commended it to the native mind. According to Mr. Emanuel

these people show traces of Negro blood, and hence it has been concluded that they are the "descendants of slaves imported by one of the conquerors of India." They are, however, I should say, an aboriginal tribe, showing neither in their complexions, character of their features, nor hair, the slightest trace of Negro origin.

When Sambalpur was taken over by the British, in 1850, the Government offered to lease out the right to seek for diamonds, and in 1856 a notification appeared in the *Gazette* describing the prospect in somewhat glowing terms. For a short time the lease was held by a European, at the very low rate of two hundred rupees per annum; but, as it was given up voluntarily, it may be concluded that the lessee did not make it pay. The facts that the Government resumed possession of the rent-free villages, while the Raja's operations had been carried on without any original outlay, materially altered the case, and rendered the employment of a considerable amount of capital then, as it would be now, an absolute necessity.

Within the past few years statements have gone the round of the Indian papers to the effect that diamonds are now occasionally found by the gold-washers of Sambalpur. All my inquiries failed to elicit a single authentic case, and the gold-washers I spoke to and saw at work assured me that the statements were incorrect. Moreover, they did not appear to expect to find any, as I did not observe that they even examined the gravel when washing.

WEIRAGURH OR WEIRAGUD, EIGHTY MILES SOUTH-EAST OF NAGPUR.

This locality, in Lat. 20° 26′, Long. 79° 31′ 30″, has been ascertained to be identical with Beiragurh in the Sobah Berar, which is mentioned in the "Ain-i-Akbari"* as possessing a diamond mine. It is also alluded to as yielding diamonds in the year 1425 by Ferishta.†

Weiragurh has not as yet been mapped geologically, and information regarding the rocks is somewhat incomplete. The Rev. Messrs. Hislop and Hunter, in their well-known Paper‡ describing the formations of the Central Provinces of India, merely say that the matrix of the diamonds is a lateritic grit, the only rock in its vicinity being quartzose and metamorphic. Hence they argue that Malcolmson,§ and after him Newbold, were wrong in inferring the identity of the sandstones of Central with that of Southern India from the supposed occurrence of the diamond in the former, and they enlarge upon the supposed fact that most of the diamond-bearing deposits, though resting on rocks of various ages, are merely superficial and recent, and that therefore the diamond does not afford a safe guide for correlating the older rocks.

The whole discussion shows misconceptions on both sides, which our present knowledge enables us, perhaps, to clear up. It is quite true that the sandstones of

* Gladwin's translation. London: 1800. Vol. ii. p. 58.

† History. Ed. J. Briggs. London: 1819. P. 406.

‡ "Journal of the Geological Society," vol. xi. p. 355.

§ "Bombay Branch Royal Asiatic Society's Journal," vol. i. p. 520.

the Central Provinces which are referred to are not of the same age as the sandstones of Southern India which accompany the diamond-bearing strata; they are in fact very much younger, and Messrs. Hislop and Hunter were no doubt correct in asserting that the diamonds of the lateritic gravel had not been derived from them. But the mention of the quartzose metamorphic rock confirms what is independently probable —namely, that the great basin of lower Vindhyan or Karnul rocks which occupies the upper portion of the Mahanadi valley stretches into the neighbourhood of Weiragurh, and it may, therefore, be suggested with a considerable degree of probability that the ultimate derivation of these diamonds is from a stratum occupying a horizon identical with that which constitutes the matrix of the Sambalpur diamonds, and as that in a general way has already been correlated with the diamond horizon in the Karnul rocks, the theories of both sets of observers contained hypotheses partly correct and partly erroneous, the correct portions respectively supplementing one another. Malcolmson and Newbold were right in supposing that the diamonds of Weiragurh indicated the existence of rocks of the same age as those of Southern India (the Karnul formation), but were wrong in supposing that the fossiliferous sandstones which they referred to included the source of the gems. On the other hand Messrs. Hislop and Hunter, while pointing out the latter mistake, did not realize the existence of another formation close by from which the gems probably did originally come. They seemed to regard the diamonds, both here and elsewhere throughout India, as being a product of superficial deposits, without reference to the nature of the beds upon which they rested.

In the *Central Provinces Gazetteer* it is stated that "good sandstone and granite are obtained near the town; and mines of diamonds and rubies were formerly worked in the vicinity." The statement that rubies were found requires confirmation. The examination of the geological structure of this neighbourhood, and a comparison of it with that of Sambalpur, will, doubtless, be undertaken ere long by the Geological Survey. If the stratum which contains the diamonds should be identified, and if its lateral extension should prove equal to the known area occupied by the Vindhyan (or Karnul) rocks, then we shall have a diamond-bearing tract probably greater in area than either those of Karnul or Bandelkhand.

Chutia Nagpur.

As already stated above, on page 25, the upper portion of Ptolemy's *Adamas flus* passes through a district named Cocconage, which would include Chutia Nagpur. Independently of this, however, there are good reasons for believing that diamonds were found in Chutia Nagpur. The following notices on the subject I quote from a Paper by the late Mr. Blochmann :*—

Kokrah (the ancient name of Chutia Nagpur) was known at the Mogul Court for its diamonds, and it is evidently this circumstance which led the generals of Akbar and Jahangiri to invade the district. I have found two notices of Kokrah in the Akbarnamah, and one in the Tuzuk-i-Jahangiri, from which it appears that Chutia Nagpur was ruled over in 1585 by Madhu-Singh, who in that year became tributary to Akbar. He was still alive

* "Journal Asiatic Society of Bengal," vol. xi.

in A.D. 1591, when he served under Man Singh in the Imperial army which invaded Orissa. "Tuzuk-i-Jahangiri (p. 155):—On the 3rd Isfandiarmuz of the 10th year of my reign (A.D. 1616) it was reported to me (Jahangiri) that Ibrahim Khan (Governor of Bihar) had overrun Kokrah and taken possession of its diamond-washings. This district belongs to *Subah* Bihar, and the river which flows through it yields the diamonds. When the river contains little water, tumuli and hollows are formed. The diamond diggers know from experience that chiefly those tumuli contain diamonds over which insects hover called by the Hindus *Jhingah*.* They pile up stones on all sides of the tumuli, and then cut into them with hatchets and chisels and collect the diamonds from among the sand and stones. Sometimes diamonds are found of the value of a lac of rupees each. The district and the diamond river are in the possession of Zamindar Durjan Sal. The Governors of Bihar frequently sent detachments into Kohrah; but as the roads are fortified and the jungles impenetrable, the governors were generally satisfied with a tribute of two or three diamonds. When I appointed Ibrahim Khan Governor of Bihar, *vice* Zafar Khan, I told him at the time of departure to invade the district and drive away the unknown petty Rajah. No sooner had Ibrahim entered on his office than he prepared himself to invade Kokrah. The Rajah, according to custom, sent a few diamonds and elephants; but Ibrahim was dissatisfied, and invaded the district before the Raja could collect his men. When he received news of the invasion he was already besieged in the pass where he used to reside. Some of Ibrahim's men who had been sent out to look for him found him with several persons, among them his mother, another wife of his father, and one of his brothers, concealed in a cave. They were deprived of the diamonds in their possession. Twenty-three elephants besides were taken. . . . . The district is now subject to me. All diamonds found in the

* Can these be Tavernier's "thunderstones?" (*vide* p. 27).

river are forwarded to Court. Only a few days ago a diamond arrived which had a value of 50,000 rupees, and I hope many more will be added to my store of jewels.' The diamond river alluded to is the Sunk.

To the present day a spot in the Sunk river is pointed out by the inhabitants as the place where the diamonds were washed for. In the year 1878 Captain Lowis, Guardian of the Chutia Nagpur estate, pointed out to me this locality on the map.

As I have pointed out on a previous page, Tavernier's Soumelpour on the Gouel was probably a town on the Koel, in the district of Palamow.

Mr. Blochmann also gives a quotation from a history of the Maharajas of Chutia Nagpur, in which is described a method of testing diamonds for flaws by affixing them to the horns of fighting rams, and states that:—

Jahangiri says the diamonds which Ibrahim Khan had brought from Kokrah had been given to the grinders. "They were now submitted to me, and among them is one which looks like a sapphire. I have never seen a diamond of such a colour. It weighs several *rattis*, and my lapidaries fix its value at 3,000 rupees, though they would give 20,000 for it if it were quite white and stood the full test."

Colonel Dalton ("Ethnology of Bengal," p. 163N), states that the Raja of Chutia Nagpur's family still possesses a diamond valued at 40,000 rupees, from these now fabulous mines. As illustrating the methods by which English officials in the olden time shook the pagoda tree, the following will be read with interest. In the year 1772 the Raja appeared before Captain Camar, commanding a force in Palamow, and after exchange of turbans acknowledged himself as a vassal of the Company.

In regard to this exchange of turbans (writes Colonel Dalton) the family annals tell a strange tale. In the Raja's turban were some very valuable diamonds, which it is insinuated had excited the cupidity of Captain Camar. The proposal for the exchange emanated, it is said, from him. He declared it was the English method of swearing eternal friendship, but the Captain had no diamonds in his head-dress, and the Raja evidently concluded that he had been rather "done" by the Company's officer.

In Gangpur, the Icha river, which is a tributary of the Ebe, is believed to have been the site of diamond washings. I have, however, myself heard the Ebe, near its sources, spoken of as the Hira (diamond) river. An early reference to Gangpur diamonds occurs in Dalrymple's "Oriental Repertory," vol. ii. 1808, p. 261.

Geology.—The geology of the localities on the Sunk and Icha rivers is not yet known. Possibly it may be found that there are outliers of the [Mahanadi-Godaveri] Vindhyan formation in their vicinity.

BANDELKHAND.

The writers who have described the diamonds and diamond mines of Bandelkhand from personal observation are many;* besides them there are also not a few†

* Franklin, Captain, "Asiatic Researches," vol. xviii. p. 100; Jacquemont, M. V., "Voyage dans l'Inde," tome i. p. 399; Adam, Dr., "Jour. Asiatic Soc. Bengal," vol. xi. p. 399; Hamilton, Dr., "Edinburgh Phil. Jour.," vol. i. p. 49; Medlicott, H. B., "Mem. Geol. Survey of India," vol. ii. p. 65; Mallett, F. R., *ibid.*, vol. vii. p. 113; Rousselet, M., "L'Inde des Rajahs," &c. &c.

† Carter, Dr., "Geological Papers on Western India;" Burton, Captain, *Quarterly Journal of Science*, N.S., vol. vi. p. 351. 1876.

who have written on the subject without having had the advantage of visiting the spot.

Franklin and Jacquemont give ample details of the mode of working and extraction of the gems, their varieties, &c. The most recent contribution on this subject is by M. Rousselet; but for the geology reference should be made to the Memoirs by Messrs. Medlicott and Mallett of the Geological Survey of India, as the more popular writers have given currency to very incorrect views on this aspect of the question.

The following is an abstract of these geological accounts:—

The diamond bed proper, a conglomerate, belongs to a group at the base of the Lower Rewahs,* which is distinguished as the "Panna shales." Outlying patches of these rocks occur as remnants of old spurs and outliers from the table-land. Occurring thus, without the usual covering of sandstone which is found on the flanks of the table-land, earlier observers were puzzled to account for the difference, and hence arose some of the confusion I have already described.

Mr. Medlicott gives the following account. At the time of his visit, the Panna miners had not got down to the diamond-bearing seam, which is not laid bare till about March in each year:—

PANNA.

The rock diggings near Panna do not cover a surface of more than twenty acres, they are on a low flat rising ground at the base of the slope from the Kymore scarp; there were five or six pits in progress. The section is—three feet of soil, on a smooth surface of boulder clay;

* *Vide supra*, p. 9.

this latter contains large and small rounded boulders of sandstone, possibly the remains of masses fallen from the retreating cliff of the Rewah ridge; its thickness is very variable, from two to twelve feet, due to the uneven surface of the subjacent rock; pebbles of the laterite iron ore are common along the bottom of the boulder bed.

The top three feet of the hard rock looks more like a reconstruction of materials than a rock *in situ*. It is an irregular streaked mass of clay, with occasional strings of broken grit bands; the crushing action which is so manifest in these upper layers extends itself to those below; contortion and fracture on a small scale are evident throughout, &c. &c.

These appearances are considered to be due to the falling of heavy masses of rock from the cliff face, which formerly existed, as it was undermined from below.

In the Panna mines, although the diamond seam is deeper than elsewhere, owing to the broken nature of the overlying strata, it is not reached by a shaft, but the miners go to the immense labour of excavating great pits, 25 feet in diameter and often over 30 feet deep, for the sake of the small patch of diamond conglomerate thus uncovered.*

KUMEREA OR KAHMURA.

This locality, which is situated to the east of Panna, was visited by Mr. Hacket, who describes it as follows. Here the matrix, locally called *Kakru*, is—

A conglomeratic sandstone made up of pebbles, one-eighth to one-half inch diameter, imbedded in a rather fine matrix which also includes clay galls. The lower Rewah sandstone here stretches out a considerable dis-

* *Vide infra*, p. 53.

tance in front of the scarp, and the pit was just on the northern edge of this terrace, some twenty feet below the summit, and itself about ten feet deep. On the top of the diamond bed was a foot or so of hard thin flaggy sandstone and about seven feet of the same mixed with shale. A little further to the south and west on this terrace was an old pit between thirty and forty feet deep, but the bottom filled with water, so that the rocks immediately above the diamond bed could not be seen, but there were certainly ten to fifteen feet of shale between it and the lower Rewah sandstone. In all the pits examined there must have been ten to twenty feet of shale intermediate. The Pannas are here very thin, so that this position is not much above the top of the Kaimurs (the lowest group of the upper Vindhyans). There are some small outlying hills to the north at the village of Bungla and north of Babupur. The former is about fifty feet high, with Kaimurs at the base, then fifteen to twenty feet of shale capped in turn by the lower Rewah sandstone; this was the only outlying hill in which the shales were seen (on account of the northern overlap). A few hundred yards to the north-east another little hill has been excavated in every direction by the old diamond searchers. Again at Babupur are numerous old pits, and some sufficiently well preserved to admit of examination. They are about fifteen feet deep, exposing sandstone with thin flaggy beds at the top, but no shales.

A bed of fine brown sandstone, including fragments of a green silicious rock, and bits of red and green shale, was traced from Bumbhen to Kissengurh, which is not impossibly the continuation of the diamond bed; that the natives do not work to the east is no proof that the beds do not continue in that direction. This is evident from the fact of there being no pits at Bungla, notwithstanding the hills all round, even to the north, having been extensively worked.

It is, therefore, almost certain that at Bungla the diamond bed exists, though untouched.

Mr. Medlicott notices the transition of the conglomerate from its position among the shales to its condition as a pure fine sandstone conglomerate.

In reference to the extension of the conglomerate, he remarks that from the nature of the case—its occurrence among fine beds—it has *per se* a precarious existence. He finds it difficult to determine the reasons why the deposit has not been worked in some localities, as at the base of the hills. In some cases, in the outlying patches, the margin of the deposit has been reached, in others it may have died out; the latter state of things might be readily ascertained were a few trenches dug in selected localities.

Mr. Medlicott makes some suggestions as to the original matrix of the gem, which I have already quoted. Besides the mines, he enumerates several localities where there were workings in accumulations of superficial detritus; these are at Udesna, Sakeriya, Mujgoan, and Boghin.

Udesna.

The mines were being worked at Udesna :—

There was water in all the pits, at what appears to be the level of the top of the boulder bed, under an irregular thickness of yellow clay, variously charged with kunkur and laterite gravel; the gangue is a stiff gravelly clay.

Sakeriya.

As at Udesna, there is a variable depth of clay, the middle third being kunkury and the lower lateritic; below this, the clay becomes charged with gravel, pebbles, and boulders, these rapidly increasing in size to great angular blocks of sandstone, scarcely moved from their original beds; it is from between these that the best stuff is got, a stiff unctuous clay, with quartz gravel through it. Above

these deep pits, which are never far from the stream, and well up on the slope of the Rewah sandstone, are diggings in the surface lateritic gravel.

MUJGOAN.

This, as suggested by Franklin, is probably the deserted gorge of a stream. Mr. Medlicott writes :—

The filling in is certainly peculiar ; the structure is like course foliation, a network of strings of calc spar, enclosing laminæ and small lumps of green clay.

In the only hole I saw they were working the yellow clay from the crevices of this ; but the men told me that at a greater depth there are alternating layers of green mud, and of its mixture with calc spar in which diamonds are found.

BOGHIN.

The mines of Boghin are thus described by Mr. Medlicott :—

At the upper end of the gorge of the Boghin river there are two falls of 200 feet each, and there are workings throughout the whole length to Kalinjer. The principal diggings were at the lower end of the mine valley ; they were removing some twelve feet of dark brown clayey sand to get at the boulder bed, in the base of which the diamonds are found, but both here and below the narrow gorge the gravel at the surface of the river bed is much worked. The natives spoke to me of a European who, some twenty years ago, had made an attempt at mining on a large scale. His diggings were on the flanks of the limestone hill, some fifty or one hundred feet over the river, the ore being a jasper gravel gathered from the deep surface crevices of the limestone. As well as I could understand their pronunciation, the man's name was Berkeley, but I have not seen any written account of his experiment ; the remains of his wash pits and picking floors are there still.*

* It is probable that the European referred to is the same as the one mentioned in the extract below.

Mr. Medlicott declines to believe in the instinct of the natives, as evinced by the capricious distribution of these surface diggings. There are many valleys in which the relation to the underlying rocks is such as to make it almost certain that the alluvial deposits contain diamonds, and yet there are no traces of workings. On the other hand, some of the workings prove the former extended range of the rock matrix, which has been broken up by denudation. He believes, further, that the occasional occurrence of diamond-bearing deposits at higher levels than the original rock matrix may be accounted for by a distribution of the materials which took place under a general submergence of the country.

The following account of the Panna mines, which seems to be well worthy of reproduction, I have extracted from an Indian newspaper. I am unable to give the author's name :—

The finances of the Maharaja are principally derived from his diamond and iron mines, and the following particulars as to how the mines are worked will prove interesting :—

In granting licences to natives the invariable rule of the Raja is to restrict the claim to diamonds below six *rattis* in weight, on which a percentage of Rs. 25 or upwards is charged. The party is then allowed to search in any spot within the territory, excepting such as are given to Brahmins for sacred purposes or are reserved for the Ranis or other relatives of the chief. The mines of Kahmura and Panna are the most celebrated, and are excavated at a depth of fifteen to fifty feet. They lie within the bounds of the rocky matrix. Those at Majgouan have also been very imperfectly used, the mining not going below fifty feet, at which depth the water overflows, and the tuadars (or masters of the mines) are com-

pelled to stop at this limit for want of a method to pump them dry. The *chila* and superficial mines are to be traced all over the diamond-tract, manual labour being cheap, as the poorest subjects of the State work them. From the commencement of the rains to the beginning of the cold season the mining goes on, since a plentiful supply of water can be had in all parts of the State—an article highly necessary to facilitate the search, as the matrix, after being dug out, is placed by small quantities in a trench, and then washed to clear it of the clay which adheres to it. A spot on the surface of the mine is *leeped* smooth with the hand, and on it the gravel is spread, and a diligent search made for the diamonds. Almost three-fourths of the people of Panna and the adjacent villages derive their living by working either for themselves or as hired labourers for others. When employed on their own account, it is not unusual to hear them complain of "no luck for months and months." Indeed, I never knew a native, during the short time I was in the State, who said he had found a diamond, but I was told that the following is the way natives carry on when at the mines. The avarice of the predecessor of the present Maharaja of Panna knew no bounds. The mines being the chief source whence his revenues were obtained, the native tuadars were never spared when they found diamonds, but had the most unreasonable taxes imposed upon them. This mischievous system, and the impolitic rule that all diamonds above six *rattis* became the *bonâ fide* property of the Maharaja, seem to have engendered in speculators a vindictive spirit, not only to evade the heavy duties but to cheat the State of the produce of the mines altogether. Every poor tuadar has a petty banker, who supports his constituents and his family with the necessaries of life, on the understanding that every diamond found by them should be sold to him, out of the amount of which he is to pay himself. In fact, a tuadar of the lower order is but an instrument to enable the Mahajans to rob the Maharaja, and it is a well-known fact that

though these harpies hoard up wealth through the medium of their artful constituents, they will, on all occasions, in order to evade suspicion, plead poverty and distress, whilst they carry on a clandestine trade of diamonds between Mirzapur, Banaras, Allahabad, and Jabalpur. Some years ago, one of these Mahajans was detected in defrauding the State of diamonds to the amount of Rs. 43,000 for a long series of years. He was imprisoned and threatened with punishment, and to avert this he refunded Rs. 16,000, and acknowledged having embezzled to the extent mentioned. It is well known that the Maharaja is robbed of large and valuable diamonds yearly. I believe only one European has ever tried working at the Panna mines, and this was in 1833, when a licence was granted him, and the following were the terms in his licence—On diamonds of 1 to 7 *rattis*, 15 per cent. on the value; from 7 to 10 *rattis*, 33 per cent.; from 10 to 15 *rattis*, 50 per cent.; from 15 to 20 *rattis*, 66 per cent.; from 20 *rattis* and upwards, *bonâ fide* the property of the Maharaja, he having the option to reward the tuadars as he pleases. The expenses for working the mines at that time were as follow :—

For one month, with 20 sets of labourers—

20 *bildars* at Rs. 2 per month . .	Rs. 40
20 water women do.	„ 30
4 sepoys at Rs. 3	„ 12
Implements for digging, &c. . . .	„ 40
Total.	Rs. 122

It shows how cheap labour was in those days, whereas at this time *bildars* are getting Rs. 12 and 14 a month. The European (his name is not given, and I copy from an old Government record) says :— "In embarking in this enterprise the chief evil to be guarded against is theft; a strict eye should be kept over the labourers during the hours of their work, as they not only pilfer and conceal

these stones in the very mines they are working, but will, in cases of emergency, swallow them! It is said that, before the British supremacy became paramount in these parts, delinquents of this description have suffered death rather than confess their having stolen the gems, which have afterwards been discovered in the ashes of their remains.

The early accounts by Franklin and Jacquemont have been, perhaps, to some extent supplanted by that by M. Rousselet. Captain Burton, in his already-mentioned Paper, gives the following abstract with some remarks of his own. While quoting from Captain Burton, I cannot omit to say that it is to be regretted that he should not have referred to the official geological publications on the subject. Had he done so he would have seen that very much more has been accomplished with regard to fixing the horizon of the matrix and its distribution than he was led to suppose, and, moreover, he would not have then rehabilitated several old theories which have been shown to be erroneous.

M. Louis Rousselet ("L'Inde des Rajahs." Paris: Hachette. 1875), in his splendid volume, pp. 440, 443, gives an illustration, and an account of the world-famous mines of Panna (the Panasca of Ptolemy?), a little kingdom of Eastern Bandelkhand erected in 1809. The Raja sent a Jemadar to show him the diggings, which are about twenty minutes' walk from the town. The site is a small plateau covered with pebble heaps, and at the foot of a rise somewhat higher than usual yawns the pit, about 12 or 15 metres in diameter by 20 deep.

It is found in alluvial grounds, divided into horizontal strata, *débris* of gneiss and carbonates,* averaging 30

* What is intended to be conveyed by the term "carbonates" I cannot say, since, other than diamonds, there are no traces of carbon in these rocks.

metres; at the bottom is the diamond rock, a mixture of silex and quartz in a gangue of red earth (clay?). The naked miners descend by an inclined plane, and work knee deep in water, which the *noria*, or Persian wheel, turned by four bullocks, is insufficient to drain; they heap the muddy mixture into small baskets, which are drawn up by ropes, whilst a few are carried by coolies. The dirt is placed upon stone slabs sheltered by a shed; the produce is carefully washed, and the silicious residuum is transferred to a marble table for examination. The workmen, each with his overseer, examine the stones one by one, throwing back the refuse into a basket. It is a work of skill on the part of both men, as it must be done with a certain rapidity, and the rough diamond is not easily distinguished from the silex, quartz, jasper, limestone, corundum, &c.

Tradition reports that the first diamonds of fabulous size were thus found, and the system of pits was perpetuated; when one is exhausted it is filled up and another is opened up hard by—a deplorable system, as 100 cubic metres must be displaced to examine one—and around each well a surface of twenty times the area is rendered useless. Moreover, much time is lost by the imperfect way of sinking the shaft, which sometimes does not strike the stone.

This diamond stratum extends more than 20 kilometres to the north-east of Panna. The most important diggings are those of the capital of Myra, Etawa, Kamariya, Brijpur and Baraghari. The mean annual produce ranges between £40,000 and £60,000—(M. Rousselet himself says 1,500,000 to 2,000,000 francs)—a trifling sum, as the stones are the most prized in the world and sell for a high price in the country.

They are pure and full of fire; the colour varies from the purest white to black with the intermediate shades, milky, rose, yellow, green, and brown. Some have been found reaching twenty carats, and the Myra mine yielded one of eighty-three which belonged to the Crown jewels of

the Mogul. Of course the real produce must be taken at double the official estimate. Despite all precautions such is the case everywhere. The Rajah has established an approximate average amount, and when this descends too low he seizes one of the supposed defaulters and beheads him or confiscates his goods.

. He sells his diamonds directly to Allahabad or Benares, and of late years he has established *ateliers* for cutting; these are the usual kind — horizontal wheels of steel worked by the foot.

On the Prospects of Diamond Mining in India by Europeans.

As I have already related, in each of the three great tracts at Chennur, at Sambalpur, and at Panna, attempts have been made by Europeans to mine for diamonds, but in no instance have their operations proved to be successful. How far success was deserved by the manner in which the operations were carried on it is impossible to state. Regarding the question, however, from a general point of view, I think it is easy to see that there are many causes which must tend to have an unfavourable effect upon the success of undertakings of this nature.

In the first place, however, it may be well to premise that there is not the least ground for supposing that there has been any real exhaustion of the localities where mining is possible. On the contrary, the result of the systematic geological examination of the different areas has been to show that the diamond-bearing strata have a wider extension there than the actual miners could have ever supposed—though not so wide as some writers have concluded, by a process of including the most distant localities in one tract, and then computing the total area.

That the ancient miners possessed and acted on a kind of rule-of-thumb knowledge of the characteristics of the diamond-bearing strata in different tracts respectively, is almost certain; but that they applied such knowledge inductively to distant tracts is extremely doubtful. The probability is that in each neighbourhood operations were commenced in consequence of chance discoveries.

The following is a recent example culled from a newspaper:—

DISCOVERY OF A DIAMOND.—The Collector of Karnul reported on the 17th December last, for the information of the Revenue Board, the discovery of a large raw diamond by one Mala Nagi of Karnul, one of the coolies employed in excavating earth in B. Class land of the Irrigation and Canal Company in Jaharapuram near Karnul. The diamond weighs 44 grains, and is said to have been purchased by Amboji, a merchant of Karnul, for Rs. 116. The real value is, of course, much higher, probably not less than Rs. 1,000. There are no diamond mines in Jaharapuram.

Prospecting far and wide, we may be sure, was never undertaken by natives, and it is doubtful whether there was any intercourse or communication between the workers at distant localities.

With scientific guidance, backed by capital and proper mining appliances, it may appear at first sight that mining by Europeans ought to succeed, but, from what has already been said in reference to Bandelkhand, it will be gathered that there are in diamond mining certain peculiarities which distinguish it from most if not all other forms of commercial enterprise. The facilities for peculation, in consequence of the readiness with which the gem may be conveyed, is of

course the principal of these. There must necessarily be a considerable amount of individual hand-work.

It would almost seem, in fact, that, except under a system of slavery, the diamond cannot be worked for profitably in India. The present system, though not so called, practically amounts to much the same thing, the actual operatives are by advances bound hand and foot to the farmers of the mines, and these are content to wait for months together without any return. Their outlay, too, is very small, no heavy expenditure of capital being involved.

The case is, in a measure, parallel to that of manufacturing iron. The native iron-smelter, with no expensive plant, manages by a most wasteful process to keep himself alive by making iron. The English company turns out iron by the most approved methods, and after a time goes into liquidation. Such has hitherto been the case, but I am hopeful of the iron industry yet proving a success in India.

I would lay no particular stress on the fact that the several attempts in Southern India, at Sambalpur and at Panna, to work mines under European management, have hitherto failed. These failures may have been due to causes with which the conditions I have above alluded to have nothing to do; they may have resulted from simple incompetency, death, or sickness, &c.

My colleague, Mr. King, in writing of the South of India mines, says that it is not to be expected that diamond mining would, except by a mere chance, prove a rapid road to fortune. But for those content with a slowly-paying occupation and a hard life, involving close personal supervision of the workers, it would pay, provided such persons possessed capital sufficient to last them some years.

CHAPTER II.

COAL.

My principal reason for preparing this account is that I find that a considerable degree of misconception exists as to the extent and value of our Indian coal fields. At the same time, from the frequency of the inquiries which have been made of me, I conclude the subject is one which many regard as being of great interest and importance.

To India, indeed, it is one of vast imperial importance, since the development of her natural resources, and the increase of local manufactures consequent thereon, seem to offer a remedy the most efficient towards establishing the equalization of the exchange.

Broadly speaking, it may be said that there are two geologies in India—namely, that of the Himalayas and that of the Peninsula proper. The former conforms in character with the recognized classification adopted in reference to European formations, while the latter differs from that of any other well-known region in the world.

Several of the formations occurring in peninsular India spread uninterruptedly over hundreds of thousands of square miles. It would, in fact, be possible to mark out areas within the limits of which two of these formations respectively prevail which would be equal to that of the British Islands.

On the present occasion it will be unnecessary to offer any sketch of the general geology, my object being to direct attention to one formation, or rather to a system of formations, and to them more particularly in reference to the coal which they contain.

The following is the classification of the subdivisions of the Gondwana system, which is at present recognized by the Geological Survey of India :—

MESOZOIC	Upper	Cutch and Jabalpur Rajmehal and Mahadeva*		Thickness 11,000 feet.
PALÆOZOIC	Lower	Panchet		13,000 ,,
		Damuda; Kamthi	Ranigunj or	
		Ironstone Barakar	Shales and	
		Karharbari and Talchir		

Dr. Feistmantel, the palæontologist of the Geological Survey of India, has, on the evidence afforded by the fossil plants, offered the following detailed correlation with European formations :—

Upper	Cutch and Jabalpur	= Lr. Oolite	
	Rajmehal	= Lias	
Lower	Panchet	= Keuper	Trias
	Damuda	– Buntsandstein	
	Talchir		

How far such identifications between parts of the world so remote from one another are to be relied on is perhaps open to question. There is much, no doubt, to be said upon both sides. It will only be possible for me to allude very briefly to the principal points at issue; but, before doing so, I propose to describe the leading characteristics of the several groups which constitute the lower portion of the above classification.

The Upper Gondwanas being of little economic importance, though of great interest otherwise, may be passed over in this communication. The two are probably separated by a very distinct break in time, as the lower are often much disturbed while the upper maintain their original horizontal positions. Taking

* The Kota Maleri beds alluded to below in the account of the Wardha field may be interpolated here.

the groups successively in ascending order, the lowest is the

TALCHIR GROUP.—The rocks composing this group consist of sandstones, fine shaly silts, and boulder beds, all of which are commonly of greenish or buff colours. The maximum thickness is 800 to 1,000 feet, but in many of the fields it does not amount to more than about one-fourth of that amount. These rocks are found at the base of all the coal fields, and also in many outlying tracts where they are not in contact with newer deposits. Of especial and general interest to geologists is one variety of boulder bed, as it affords evidence of the existence of floating ice at the time of its deposit in latitudes running as low as 16° 30′ N.

It is of importance, however, to reiterate the fact, that in these rocks we find the first traces of life in India, the vast thicknesses of rock deposited in previous periods being, so far as we know, *azoic*. These first forms consist chiefly of equisetaceous plants and ferns—all of them, I believe, such as might have existed in a moderate temperate climate.

The area through which, often at widely separated intervals, exposures of these beds are scattered, may be roughly indicated by saying that it occupies the higher central parts of the Peninsula, being bounded by the 77° and 88° of east longitude, and the 16° 30′ and 25° parallels of north latitude.

The Talchir beds are of no economic importance, save that they contain several varieties of easily worked, durable, and sometimes ornamental building stones. Limestones are rarely found; generally they occur merely as concretionary masses in other rocks. From their scattered distribution and limited extent they can scarcely be expected ever to prove of much value.

KARHARBARI GROUP.—This group of beds, which consists of conglomerates, sandstones, and coal, was long considered, in consequence of the strong lithological resemblance which its members bore to the Barakar rocks, to belong to that group. Recent palæontological investigations, by Dr. Feistmantel, are considered to be of sufficient weight to cause it to be classed in closer proximity to the Talchir group, a number of species of plants having been found common to both; but the physical relations between the Karharbari beds and those of the Talchir group seem to be identical with those existing between the Barakars and the latter, and there is not any sign in the lithological characters, or in the conditions of deposit thence deducible common to the Talchir and Karharbari groups. Attempts to point lithological distinctions as existing between the Karharbari and Barakar beds appear to me to be somewhat strained, and not very successful. The differences are simply such variations as might have been determined by local conditions of deposit. I believe, therefore, that the fossil evidence merely proves a survival of certain species, and cannot be taken to counterbalance the geological evidence as to a marked separation between the deposition of the Talchir and succeeding groups.

The Karharbari rocks were named after the coal field bearing that title; they have also been identified at Mopani. Their thickness is 500 feet.

BARAKAR GROUP.—This group of rocks, from which, as I have said, I believe the Karharbari beds cannot be separated, consists of sandstones, grits, pebble conglomerates, conglomerates with angular fragments, carbonaceous and other shales, and coal. Except in some of the eastern fields of the Damuda valley series, this group includes all the valuable coal of Peninsular India.

The thickness attains its maximum in the Jeriah coal field, where it is estimated to be 3,800 feet. In the Ranigunj field it is 2,000 feet; in most of the other fields it is much less.

IRONSTONE SHALE GROUP.—This group, consisting of bands of ironstones, running through grey and black (carbonaceous) shales, overlies the Barakar group with general conformity. It is only found in the Damuda Valley fields, wholly disappearing further west.

In the Bokaro field it attains its maximum thickness of 1,500 feet.

RANIGUNJ (KAMTHI) GROUP. — The Ranigunj group consists of sandstones—which are fine-grained and often calcareous—carbonaceous shales, and coal. The coal is generally of better quality and more uniform in composition and in the thickness of seams than is that of the Barakar group. In the easternmost field of the Damuda Valley series—namely, the Ranigunj, which has given the name to the group—the principal coal seams which are worked belong to this group. In the more western fields it steadily thins out, the coal becoming of less and less importance.

In the central fields of the Peninsula it is very much changed in lithological characters, and is so greatly increased in thickness, amounting to from 5,000 to 6,000 feet, that the true identity with it of these latter deposits which constitute the so-called Kamthi group is established only by general geological relations aided by fossil evidence.

The rocks of the Kamthi group are largely made up of coarse sandstones and conglomerates, in which there is a prevailing reddish colour due to the amount of iron always present. Coal rarely occurs as a member of this group; its importance is insignificant.

For fuller accounts of the lithological characters and fossil contents of the above beds I must refer the reader to Mr. Blanford's account of them in the "Manual of the Geology of India."

The groups of the Upper Gondwanas do not contain workable coal, but their presence in the several fields covering and sometimes wholly concealing the coal-measures confers on them indirectly a considerable economic importance.

Age of the Plant-Bearing Series of Rocks included in the Gondwana System.

I have already given the proposed correlations of the several series or groups of Gondwana rocks with European formations, but it may be well to add a few general remarks on the subject.

Some of those now present who are readers of the *Geological Magazine* may, perhaps, have scented the battle which has been waged afar off as to the homotaxy and correlation of these rocks with those of the recognized European sequence.

Perhaps the most important recent result of the examination of the fossil plants has been the discovery that *Glossopteris* (a genus of ferns), which was formerly thought to be characteristic of the Lower Gondwanas, has been found to occur in the very highest group of the Upper Gondwanas—viz., Jabalpurs. On the other hand, several species of Cycadaceous plants, which order was supposed to be restricted to the upper groups, have been found to exist in the lower or Damuda groups,* thus to a great extent binding the whole

* The Damuda Cycadaceous plants are—*Noeggerathia Hislopi.*, Bunb., *Macropterygium* Comp. *Browni*, Schimp., *Pteropbyllum Burdwanense*, Fstm., *Glossozamites Stoliczkanus*, Fstm., *vide* "Records Geological Survey of India," vol. x. pt. 2.

system of groups or series together, and drawing them away from the floras characteristic in other countries of palæozoic periods.

But what have been called palæontological contradictions occur in these rocks, for it has been found, with reference at least to some of the higher or younger groups, that the marine faunas, where present, do not always point to the same conclusions as the floras.

In the Annual Report of the Survey for 1876, this state of things was summarized by Mr. H. B. Medlicott in the following words :—

> The facts of our Gondwana rocks are certainly puzzling to systematists. On the west, in Kach, we have the flora of the top Gondwana group, which has a Bathonien *facies* associated with marine fossils of Tithonien affinities ; while on the S.E., in the Trichinopoli beds, with a *flora*, so far as known, like that of the Rajmahal group, which is taken to be liassic, have been described by Mr. H. Blanford as overlaid in very close relation by the Otatoor group, the *fauna* of which has been declared upon very full evidence to have a Cenomanien *facies*.

Another instance of these contradictions I quote from the "Manual," p. 100 :—

> The Kota beds, with their liassic fish, have now been so closely connected with the Maleri clays and sandstones, containing triassic reptiles and fish and jurassic fish, that both are classed in the same group.

The occurrence of several genera of Damuda plants, more particularly *Glossopteris*, in the higher Australian coal-measures, passing thence downwards into beds containing carboniferous marine fossils, and, lower still, typical carboniferous plants, has been used as an argument in favour of the view that our Indian coal-

measures are Palæozoic. Dr. Feistmantel maintains, however, that the Australian upper coal-measures are triassic, while the lower are undoubtedly carboniferous, *Glossopteris* having survived. Some of the Australian sections, however, scarcely support the view of a distinct separation being possible.

Mr. W. T. Blanford is of opinion that

> The whole evidence, so far as it goes, both of animals and plants, tends to connect the whole of the Gondwana series with formations ranging from the upper Palæozoic (Permian) to the lower Jurassic.

It is clear that *floras* alone afford but an unsafe guide to correlation, and for this reason, that they, as well, also, as some land animals, appear to have often survived the wholesale changes which have affected the faunas of the neighbouring seas and oceans.

Although, therefore, it may be dangerous to attempt a close correlation of the Indian formations with those of distant countries by the evidence afforded by fossil plants, still the advantage of employing such evidence as a means of identification between widely-separated deposits within the limits of India cannot be doubted.

ORIGIN OF THE GONDWANA ROCKS.—From the evidence afforded by the fossils, and the lithological characters of the rocks, it is probable that the Gondwana strata were deposited in a series of river valleys not unlike those which constitute the Indo-Gangetic plains at the present day. The rivers were generally sluggish in their movements and occasionally may have formed lakes.

AREAS OF GONDWANA ROCKS.—The following Table of the areas of the Indian coal-measures and associated

younger rocks which may conceal coal-measures has been drawn up by my colleague, Mr. Hughes :*—

Godaveri and affluents . .	11,000	square miles.
Sone	8,000	„
Sirguja and Orissa, &c. . .	4,500	„
Assam	3,000	„
Narbuda and affluents . . .	3,500	„
Damuda	2,000	„
Rajmahal area	300	„
Unsurveyed, &c.	2,700	„
	35,000	

For the sake of comparison other countries with greater areas are enumerated :—

United States	500,000	square miles.
China	400,000	„
Australia	240,000	„

India comes next or fourth on the list. Although I believe Mr. Hughes' estimates require some modifications in detail, still the total cannot be far from correct, and 30,000 square miles might, I think, perhaps be safely adopted as a minimum.

List of Separate Coal Fields.

Bengal.

1. Rajmahal Hills . .	North of Damuda River.
2. Birbhum	
3. Deogurh	
4. KARHARBARI,† . .	
5. RANIGUNJ	Damuda Valley.
6. Jeriah	
7. Bokaro	
8. Ramgurh	
9. Karanpura, N. . .	
10. Karanpura, S. . . .	

* "Records," vol. vi. p. 65.

† Fields which are worked printed in small capitals.

11. Chopé	West of Damuda Valley.
12. Itkuri	
13. Aurunga	
14. Hutar	
15. DALTONGUNJ	
16. Tattapani	Sone and Mahanadi Valleys.
17. S. Rewah and Sohagpur	
18. Jhilmilli	
19. Bisrampur	
20. Lukanpur	
21. Rampur	
22. Raigurh and Hingir	
23. Udaipur and Korba	
Orissa.	
24. Talchir	
Central Provinces.	
25. MOPANI	Satpura Region.
26. Tawa	
27. Pench	
28. Bandar	Godaveri Valley.
29. WARDHA or CHANDA	
30. Kamaram	
31. Singareni	
Sikkim.	
32. Sikkim.	
Assam.	
33. Makum	Valley of the Brahmaputra.
34. Jaipur	
35. Nazira	
36. Jangi	
37. Disai	

In the above list, localities, chiefly situated in the North-West Provinces, Assam and Burmah, where tertiary coal occurs, but not in sufficient quantity to constitute workable coal fields, have not been included.

Of the thirty-seven separate coal fields only five are at present worked with regularity. These are Ranigunj, Karharbari, and Daltongunj in Bengal, and Mopani and Wardah in the Central Provinces.

In the following abbreviated notes I endeavour to give the chief points of importance regarding each field, while the references to the publications of the Geological Survey will indicate the sources from whence fuller details may be obtained:—

LOWER BENGAL.

I. Rajmahal Area.*

The Rajmahal hills form a series of low plateaus, which are situated at the point where the Ganges turns southwards to form the head of its delta.

The formations in this area, which are connected with the coal-measures, are, in descending order, as follows:—1. Laterite. 2. Rajmahal Group, consisting chiefly of contemporaneous traps, with beds containing fossil plants, 1,500 feet. 3. Dubrajpur Group (= Mahadevas), 450 feet. 4. Barakar Group (= coal-measures). 5. Talchir Group. These cover a total area of about 4,000 square miles. The coal-measures are exposed over seventy square miles, but doubtless extend over a vastly greater area underneath the younger formations. Separated by these overlying rocks, five distinct areas or fields may be enumerated —1. Hura; 2. Chuparbhita; 3. Pachwara; 4. Mhowagurhi; 5. Brahmani. These are all on the western margin of the hills. It will be an interesting and economically important point to decide, whether the coal-measures extend underneath the traps, &c., to the

* "Mem Geol. Survey of India," vol. xiii. Also "Manual," pp. 165, 171.

east. If so, they would be close to the water carriage of the Ganges.

The coal is, for the most part, stony and bad. It is not now regularly mined, but a large quantity was extracted during the construction of the East Indian Railway.

II. & III. Birbhum, Deogurh, &c.*

A number of small detached basins or outliers occur in the districts of Birbhum and Deogurh where metamorphic rocks mainly prevail. They are of little or no economic importance, and may be passed in this record without farther notice.

IV. Karharbari or Kurhurbali.†

This small field, having an area of only 11 square miles, and which is situated in the district of Hazaribagh, at a distance of 200 miles from Calcutta by rail, is one of great importance, both from its position and the quality of its coal. The sedimentary groups of Gondwana rocks represented in this area are Barakar and Karharbari, 500 feet (= coal-measures), and Talchir, 600 feet.

The coal occurs in three principal seams, which have an average total thickness of 16 feet. They spread over an area of 8½ square miles. The amount of coal may therefore be estimated at 1,360,000,000 tons, and the available portion of this at 80,000,000.

A sample assay gives the following results—carbon, 66·3; volatile matter, 23; ash, 10·7. In working power, the Karharbari coals are to those of the Ranigunj field as 113 : 100.

* Hughes, "Mem. Geol. Survey of India," vol. vii. pp. 247, 255. "Manual," p. 171.

† Hughes, *loc. cit.*, p. 299.

Several companies are engaged in working mines in this field—namely, the East Indian Railway, the Bengal, and the Ranigunj Coal Association. Owing to the want of any proper system of registration in India, it is impossible to give accurate statistics, but I believe that up to June, 1875, the East Indian Railway had extracted 350,000 tons. The following I quote from the Report of the Company for the year 1878:—

The out-turn of steam coal and rubble from the Company's collieries, during the year 1878, was 208,790 tons. The quantity consumed on the main line was 162,370 tons, at an average cost (exclusive of carriage) of 5*s.* 5*d.* per ton; and on the Jabalpur line, 17,600 tons, at an average cost of £1 2*s.* 4¾*d.* per ton (carriage included). Regular mining was not commenced in this area till about ten years ago, when a branch from the Main Trunk Line brought the coal into successful competition with that from Ranigunj, twenty-three miles being saved in the journey up country.

V. RANIGUNJ.*

This field is situated on the rocky frontier of Western Bengal, at a distance of from 120 to 130 miles from Calcutta.

The groups represented, with their respective thicknesses, are as follows:—

Upper Panchet or Mahadeva . .	500 feet.
Panchet	1,500 „
Ranigunj	5,000 „
Ironstone shale	1,400 „
Barakar	2,000 „
Talchir	800 „
Total . .	11,200 „

* Blanford, "Memoirs Geological Survey of India," vol. iii.

The Ranigunj coal-field is the largest and most important of the areas in which coal is worked in India. Its proximity to the main line of railway, and also to the port of Calcutta, tends to give it pre-eminence over other less favourably situated localities. The total area of coal-bearing rocks which is exposed is about 500 square miles; but it is possible that the real area may be even double that, since on the east the rocks dip under and are completely concealed by alluvium. Throughout this area a central zone includes the principal mines, and the chimneys which dot this tract constitute it the Black Country of India. In the year 1774 coal was known to occur there, and so long ago as 1777 was actually worked. In 1830 several collieries of considerable extent had been opened out and were, we have reason to believe, in a flourishing condition.

In 1872, forty-four mines were at work, nineteen of which turned out upwards of 10,000 tons each *per annum*. At the present time (1879) there are about six principal European companies engaged in the extraction of coal, while many minor firms and native associations contribute to swell the total amount raised.

Formerly a large proportion of the coal was obtained by open workings and quarries; but at the present day most of the seams which were accessible in this way have been exhausted, and regular mining is now carried on with more or less system.* The miners are, however, individually, in some cases, allowed a degree of freedom, or rather licence, which would never be permitted in European mines. They chiefly belong to two races, the Bhowries and the Sontals—the former using the pick, while the latter cannot be

* Some of the mines are now admirably managed.

induced to work with any other tool than a crowbar, with which they produce an altogether disproportionate amount of small coal and dust. The pillar and stall is generally practised in preference to the long wall system of "getting" the coal. None of the mines are of great depth, and a perfect freedom from fire and choke damp render it possible to carry on the work without its being necessary to adopt the precautions which in England only too often fail to secure the object aimed at. Many of the seams are of considerable thickness; one which is worked contains nearly 40 feet of coal. As a rule, however, the thick seams, especially those in the lower measures, do not contain the best coal. Compared with ordinary English coal, the Ranigunj coals, and Indian coals generally, are very much inferior in working power. Still they are capable of generating steam in both locomotive and other engines. In 1868 the total amount of coal raised in the Ranigunj mines was 564,933 tons; but in 1872 the total amount was only 322,443 tons.

I quote the following from the resolution on the subject by the Lieutenant-Governor of Bengal for the year 1879:—

> The year was a prosperous one for the coal companies of Ranigunj. There was a large demand, and production was greatly stimulated. The output is estimated to have been 523,097 tons against 467,924 tons, the average of the three previous years. The number of persons employed was 388,931 men, 194,647 women, and 27,277 children.

The coal, which is fairly representative of Indian coals, may be described as a non-caking bituminous coal, composed of distinct laminæ of a bright jetty and of a dull, more earthy rock.

The average of thirty-one* assays of samples from different mines gave the following results:—

Moisture	4·8
Volatile	25·83
Carbon (fixed)	53·2
Ash	16·17
	100·

The cost of steam coal at the pit's mouth is from 2½ to 3 rupees, say 5 to 6 shillings. In Calcutta the same coal costs 14 to 16 shillings, and in Lahore about £5.

VI. JERIAH.†

The Jeriah coal field is situated in the valley of the Damuda river, sixteen miles west of the Ranigunj field. Its area is about 200 square miles.

The following groups only occur, the highest groups of the Ranigunj field being unrepresented:—

Ranigunj	2,200	feet.
Ironstone shales . . .	700	„
Barakar	3,000	„
Talchir	900	„
	6,800	„

The thickness and quality of the seams vary a good deal, but there is no doubt whatever that this field contains a vast quantity of valuable fuel. One seam has a maximum thickness of 60 feet. The estimated available coal in this area is 465 millions of tons.

* *Vide* "Records Geological Survey of India," vol. i. p. 155.

† Hughes, "Memoirs Geol. Survey of India," vol. v. "Manual," p. 185.

Whether this field will ever be worked depends very much upon the laying out of a new line of railway communication. The exhaustion or partial exhaustion of coal in the Ranigunj area, an event still far distant, may lead to special arrangements for working it.

VII. Bokaro.*

The Bokaro field is situated in the valley of the Damuda, commencing at a point two miles west of the termination of the Jeriah field. Its area is about 220 square miles.

The groups represented in this field are precisely identical with those of the Ranigunj field, namely:—

Mahadeva	—
Panchet	—
Ranigunj	—
Ironstone shale	1,500 feet.
Barakar	—
Talchir	—

Some of the coal seams are of large size, one, of eighty-eight feet, having been measured. The quality is generally inferior. Still there is no doubt that the field contains a vast store of valuable fuel. The estimated available coal is 1,500,000,000 tons. Except by outcrop workings nothing has been done to develop the resources of this field. Owing to its position it is not likely, unless by the establishment of some local industry, that it will ever become available for useful purposes.

* Hughes, "Mem. Geol. Survey of India," vol. vi. "Manual," p. 187.

VIII. Ramgurh.*

This field is situated to the south of the Bokaro field in the valley of the Damuda. Its area is 40 square miles.

The following groups only occur, as in the case of the Jeriah field; it is uncertain whether the higher groups were denuded or were never deposited:—

Ranigunj	? feet.
Ironstone shale	1,200 „
Barakar	3,000 „
Talchir	850 „

The coal is, for the most part, of poor quality and limited in extent. There are, however, a good many seams; possibly when opened up they may prove to contain better fuel than any which is now exposed in natural sections. But the field is unfavourably situated with regard to lines of communication.

IX. & X. Karanpura, North and South.†

These fields are situated at the head of the Damuda valley. Their areas respectively are 472 and 72 square miles.

The groups occurring are the same as in the Bokaro field, save that in the southern field there has been no trace of Panchets yet discovered:—

Mahadeva	300 feet.
Panchet	? „
Ranigunj	? „
Ironstone shale	600 „
Barakar	1,500 „
Talchir.	400 „

* "Mem. Geol. Survey of India," vol. vi. "Manual," p. 190.

† Hughes, "Mem. Geol. Survey of India," vol. vii. "Manual," pp. 191–196.

The following is an assay of a sample of the better class of coals in these fields :—

Carbon	64·5
Volatile	27·0
Ash	8·5
	100·

The estimated amounts of coal are, for the larger field (North Karanpura), 8,750,000,000 tons, the estimated total thickness of seams being 38 feet. In the South Karanpura field the estimated amount is 75,000,000 tons, the thickness being 70 feet.

The situation of these fields in a deep valley surrounded by hills, renders it improbable that this vast amount of coal will ever become available for economic purposes.

XI. Chopé.*

This is a small field of less than one square mile in extent. The chief point of interest about it is its position, which is on the Hazaribagh plateau, at an elevation of about 2,000 feet above the sea, or nearly 1,000 above the nearest fields in the valley of the Damuda.

The groups represented are the Baakar and Talchir.

There is only one seam of coal, and it is of poor quality.

* "Mem. Geol. Surv. India," vol. viii. "Manual," p. 196.

XII. Itkuri.

This field is situated about 25 miles north-west of Hazaribagh. The Barakar coal-measures, which include a few seams of inferior coal, are exposed only over half a square mile. The remainder of the area is made up by rocks of the Talchir group.

XIII. Aurunga.†

This field is situated in the district of Lohardugga, to the west of the sources of the Damuda, in the valley of the Koel, a tributary of the Sone. The area is 97 square miles, and the groups represented are:—

Mahadeva	1,000 feet.
Panchet	700 „
Ranigunj	1,000 „
Barakar	1,500 „
Talchir	300 „
	4,500 „

There are numerous coal seams, some of large size, the estimated amount of coal which they contain being 20,000,000 tons.

The following average proportions of constituents, derived from the assays of seven samples from different localities, indicate a very poor quality of fuel.

Moisture	6·7
Volatile	29·3
Carbon	36·5
Ash	27·5
	100·0

* Hughes, "Mem. Geol. Survey of India," vol. viii. p. 321. "Manual," p. 197.

† "Mem. Geol. Survey of India," vol. xv.

Valuable and extensive deposits of iron ores and limestones occurring in and near the coal field, this inferiority of the coal is to be lamented, as, should a project for manufacturing iron there ever be adopted, fuel, it seems probable, will have to be obtained from some of the neighbouring fields.

XIV. HUTAR.*

This field lies to the west of the Aurunga, being situated more directly in the valley of the Koel. The area is 78·6 miles, and the following groups occur :—

Mahadeva	1,000 feet.
(Ranigunj ?) Barakar	2,750 „
Talchir	300 „
	4,050 „

Data for the estimation of the quantity of available coal are wanting, but there is a considerable number of seams, and the average of eight assays gives the following favourable result :—

Moisture	5·95
Carbon	55·35
Volatile	28·
Ash	10·7
	100·

XV. DALTONGUNJ.†

This field is also in the valley of the Koel, in the District of Lohardugga. The area is 200 square miles. Two

* "Mem. Geol. Survey of India," vol. xv.

† Hughes, "Mem. Geol. Survey of India," vol. viii.

groups only are represented—viz., the Barakars and Talchirs, the latter being about 500 feet thick.

Seams of coals are not numerous. One, which has a thickness of about 5 or 6 feet, contains excellent fuel, according to the Indian standard, as the following average of four assays amply testifies:—

Moisture	3·45
Volatile	21.05
Carbon	64·8
Ash	10·7
	100·

The estimated total of available coal is 11,600,000 tons.

This field has been worked to a small extent from time to time. There is some prospect of its being now opened up in connection with the Sone river canal system.

XVI. Tattapani.*

Besides a few notes by myself, the result of a day devoted to the examination of its eastern frontier, nothing is published yet regarding this field, but a detailed account is, I understand, about to appear. The formations found in the Aurunga Field all occur there, and there is some coal. On the southern faulted boundary there is a remarkable series of hot springs, from which the locality has received its name Tattapani (boiling water).

XVII. South Rewah and Sohagpur.†

This is a wide tract in the Sone valley, covering perhaps 8,000 square miles. The geology is imper-

* "Mem. Geol. Survey of India," vol. xv.

† "Manual" vol. i. p. 201.

fectly known; it is probable that nearly all the recognized groups of the Gondwana formation are represented within the area. Coal occurs, but little information has as yet been ascertained regarding its average quality and total amount.

XVIII. JHILMILLI.*

This is a small area of about 35 square miles, which has not yet been fully examined. Besides Talchir and Barakar rocks, one or more of the younger groups are represented.

Coal seams of some promise have been observed in the Barakars. Traces of coaly matter, forming a seam of six inches, were also discovered in the Talchirs, a quite exceptional circumstance.

XIX. BISRAMPUR.†

This field occupies the central basin of Sirguja at an elevation of about 1,800 feet above the sea. Its area is about 400 square miles. The formations met with are:—

Mahadeva	1,000 feet.
Barakar	500 „
Talchir	200 „

A large number of coal seams has been discovered, some containing good coal, but, so far as at present known, they are not of great promise. This is of less importance, since the locality is so landlocked that it is never likely to be the scene of mining operations.

* "Manual," vol. i. p. 204.

† "Records Geological Survey of India," vol. i. p. 205.

XX. LUKANPUR.*

This field lies to the south of the Bisrampur area, from which it is separated by a fault and a belt of Talchirs, with inliers of metamorphic and sub-metamorphic rocks. Its total extent has not yet been ascertained, but it is probable that it is continuous with a large area of coal-measure rocks, believed to exist far to the westward.

Several seams of coal have been discovered, one of which is five-and-a-half feet thick, and contains good coal. The rocks belong to the Barakar and Talchir groups.

XXI. RAMPUR.†

This area adjoins the last on the north, and it is probable is more or less connected with that which follows, but it is partly situated in a different catchment area near the sources of the Rer river, a tributary of the Sone, while the field about to be described is wholly within the limits of the Mahanadi basin. The rocks of this portion consist of Mahadevas, Barakars, and Talchirs. No good coal has been observed yet. The most remarkable seam is situate at the base of the massive square block of Mahadevas known as the Ramgurh Hill.‡ Above it issues a perennial fountain of water, which, with some other peculiarities, have caused the spot to be regarded as one of great sanctity by the natives.

* MS. Notes, "Manual," vol. i. p. 206.
† *Ibid.*, vol. i. p. 207. ‡ "Jungle Life in India," p. 324.

XXII. Raigurh and Hingir.—Udaipur and Korba.*

The above-named places are situated in a wide extent of coal measures and associated rocks, which cover an area of not less than 1,000 square miles. The country is very wild and difficult of access, and our knowledge of the field is as yet imperfect. Especially this is the case as to the identity of the rocks younger than the Barakar coal measures. There appear to be two distinct groups, one containing fossil plants, which serve to correlate it with the Kamthi-Ranigunj group, the other being probably of Mahadeva age, but, owing to the great similarity in lithological characters, separation has been attended with great difficulty and uncertainty.

The coal seams are sometimes of enormous size, thicknesses as great as 90 feet, and even 168 feet, having been measured; but, although containing good coal, these are often largely made up of carbonaceous shale, which is incapable of supporting combustion.

In one locality, the Samarsota river, the coal seams have been greatly disturbed, being bent into an anticlinal, at the crest of which the lowest rocks of the area are exposed.

Should a direct line ever be made, connecting Calcutta with the Central Provinces, this field will doubtless be opened up, and may, in that contingency, become of great importance.

* Blanford, "Records G. S. I.," vol. iii. p. 54. Ball, *id.* v. pp. 101, 107; viii. pp. 102, 121; and x. pp. 170, 173; "Manual," pp. 206, 210.

ORISSA.

XXIII. TALCHIR.*

The Talchir coal field is situated in the valley of the Brahmani, which may be regarded as a tributary of the Mahanadi, since it anastomoses with it in the con joined deltas. The field is really the south-eastern extension of the last-mentioned area, the separation being inconsiderable.

The area is about 700 square miles in extent.

The groups represented are similar to those found in the last area, and have the following estimated thicknesses :—

Mahadeva } Kamthi }	1,500 to 2,000 feet.
Barakar	about 1,800 „
Talchir	500 „

The Talchir group received its name from this locality, where it was first discriminated.

The coal is of inferior quality, one large seam being similar in character, being largely made up of carbonaceous shale, to that described above in Hingir.

The demand for coal in Orissa is too limited to render it probable that under present conditions of communication the field will ever be of much value.

Further to the south-east, near the town of Cuttack, there is an area of sandstones and conglomerates in which fossil plants of the Rajmahal type occur.

* Blanford and Theobald, "Mem. Geol. Survey of India," vol. i. pp. 33, 38. Also see "Records," vol. x. pp. 170, 173; and "Manual," vol. i. p. 210.

SATPURA BASIN.*

The Satpura region, so called from one of the ranges of hills, consists of a hilly tract separating the valleys of the Narbada and Tapti rivers.

It is difficult to speak of this area as a single expanse of coal-measures, since, as a matter of fact, they only appear at intervals under the margins of younger groups, covering a wide extent of country, which stretches for a distance of about 170 miles. Accordingly, the estimated dimensions of the basin vary much according to different authorities.

About 2,000 square miles appears to be a safe minimum, but besides this it should be remembered that there is a considerable tract in which the underlying formations are concealed by the tertiary Dekan traps, and a large area towards Jabalpur, in which no coal-measures have been proved to exist under the younger formations which prevail there.

In this region the several groups of the Gondwana system are developed to their maximum extent. They have been named and classified by Mr. H. B. Medlicott as follows :—

Upper Gondwana.

Jabalpur group		1,000 feet.
Mahadeva Series.	Upper—Bagra . . .	800 ,,
	Middle—Denwa . .	1,200 ,,
	Lower—Pachmari .	8,000 ,,
	Forward . .	11,000

* J. G. and H. B. Medlicott, "Memoirs Geological Survey of India," vol. ii. pp. 97, 267; x. pp. 133, 188. "Records Geological Survey of India," vol. iii. pp. 63, 70, and viii. pp. 65, 86.

Lower Gondwana.

		Forward .	11,000 feet.
Damuda Series.	Upper	Bijori group .	4,000 „
		Motur „ .	6,000 „
	Lower—Barakar and Karharbari group . .		500 „
Talchir group			1,000 „
			22,500

It is not contended that this enormous thickness of rock was ever successively deposited in vertical order in any one locality. The figures are to be taken as the maxima of the deposits of successive periods.

The principal localities where coal measures occur are near Mopani and in the valleys of the Tawa and Pench rivers. The former is on the northern boundary.

XXIV. Mopani.*

This field is one of high importance, in consequence of its position with reference to the railway. It is situated 95 miles (by rail) W.S.W. of Jabalpur, and 322 miles from Allahabad, or 83 miles nearer than the Karharbari field to the same place.

The area in which coal has been proved to exist is small, though recently an important addition appears to have been made. The old area is much cut up by faults, and the largest seam has been destroyed by fire. The seams are:—

1. Inferior coal	12 feet, not worked.	
2. Good cooking coal . . .	18–20 feet, on fire.	
3. Good coal	3 feet 4 inches	worked
4. 10 feet good coal	12 feet	together.

* Medlicott, "Memoirs Geological Survey of India," vol. ii. 1859; vol. x., 1873. "Records," vol. iii., 1870; vol. iv., 1871; vol. v., 1872; vol. viii., 1875; vol. xii., 1879.

These seams are, and have been, worked for many years by the Narbada Coal and Iron Company. In 1874 the out-turn ranged from 700 to 1,000 tons per month. It was sold to the railway company at about ten rupees, or at from three to four times the price of Ranigunj and Karharbari coals. It could command this price in consequence of the cost of carriage respectively of Karharbari, and of English coal from Bombay.

In 1878, the average cost of Karharbari coal on the line between Jabalpur and Allahabad amounted to £1 2*s.* 4¾*d.* per ton.

XXV. Tawa.*

The coal seams of the Tawa valley are of no great promise; they are of irregular thicknesses and the coal is generally inferior.

XXVI. Pench.†

There are many seams in this area, some of which are of considerable thickness, and the coal is often of fair quality. The position of the field, surrounded by hilly country, renders it improbable that it will ever be of much commercial value.

GODAVERI VALLEY.

XXVII Bandar.‡

This field is situated near the village of Chimur, thirty miles N.E. of Warora, in the Chanda district.

* "Manual," vol. i. p. 218. † *Loc. cit.*

‡ Hughes, "Memoirs Geological Survey of India," vol. xiii. pp. 145–154. "Manual," vol. i. p. 226.

The existence of coal measures under a small tract of Kamthi beds, 5 to 6 miles square, has been proved by boring. Three seams of coal have been ascertained to exist, and these have a maximum total thickness of 38 feet. The coal is similar in character to that of Warora.

XXVIII. Wardha or Chanda, &c.*

This coal field constitutes the northernmost extremity of an immense tract of Gondwana rocks, which extend for about 285 miles from north-west to south-east in the valleys of the Wardah, Pranhita, and Godaveri basins.

The groups of rocks exposed are as follows :—

Upper Gondwana.

Kota Maleri	1,500 feet.
Kamthi	2,500 to 3,000 „
Barakar	250 „
Talchir	500 „

Any attempt to give an idea of the distribution of coal measures throughout this area, without employing a mass of detail unsuited to this Paper, would certainly fail. I shall therefore confine myself to quoting Mr. Hughes' estimate of the amounts of coal, in several of the particular tracts, where its existence has been proved by actual outcrops or by borings :—

* Hughes, *loc. cit.*, pp. 1–145.

	Actual quantity. Tons.		Amount available. Tons.
Warora basin	20,000,000	...	14,000,000
Ghugus	90,000,000	...	45,000,000
Wun	2,100,000,000	...	1,500,000,000
Between Wun and Papur	105,000,000	...	50,000,000
„ Junara and Chicholi	150,000,000	...	75,000,000
Sasti and Paoni basins .	60,000,000	...	30,000,000
	2,525,000,000		1,714,000,000

The following assays will serve to convey some idea of the quality of the coals :—

	Warora.		Pisgaon.		*Ghugus.
Fixed carbon . . .	45·4	...	65·1	...	45·61
Volatile combustible	26·5	...	19·2	...	33·49
Water	13·9				
Ash	14·2	...	15·7	...	20·90

In Mr. Hughes' report assays of samples from other localities are also given.

The Warora coal is deficient in fixed carbon, a larger percentage of which is essential where great heating power is required. It also is deficient in combustible volatile gases. Pisgaon coal, however, contains a more considerable proportion of fixed carbon—viz., 65·1 per cent.

The only pits in this wide area which are worked are at Warora, where the out-turn was, in 1878, 1,500 tons per week. The great outlay by the Government in connexion with the exploration and testing of the field† has not yet been nearly repaid, the cost of extraction being heavy.

* Average of sixteen assays.

† £600,000 is stated to have been already expended at Warora alone at the time Mr. Hughes' report was printed.

A special branch line conveys the Wardha coal to the Nagpur branch of the Great Indian Peninsula Railway, by means of which it is distributed both for use on this line and in factories.

Several other small areas of coal-bearing rocks occur farther down the course of the Godaveri valley at Dumagudium, Mudavaram, &c. &c., to which much interest has attached, as it was hoped that they might yield a supply of coal for the Madras Presidency, but the prospect of their doing so does not appear to be a good one.

XXIX. KAMARAM.*

This name has been given to two small fields situated near the village of Kamaram, which lies forty miles a little north of east from Warangul, in the Haidrabad territory.

The larger one is six miles long by about one mile broad; it consists of Talchir, Barakar, and Kamthi rocks. It includes two coal seams of fair coal, measuring respectively 9 feet and 6 feet. The available coal is estimated at $2,265,120 \div 2 = 1,132,560$ tons, and it is stated to be equal to the average coal of the Wardah fields. Its position is unfavourable to its development, water carriage being too far distant.

The smaller field, which is about half a square mile in area, is of no importance.

XXX. SINGARENI.†

This field is situated near the village of Singareni, in the Haidrabad territory, about thirty miles to the

* King, "Records Geological Survey of India," vol. v. p. 50. "Manual," vol. i. p. 240.

† King, *loc. cit.*, p. 65. "Manual," vol. i. p. 241.

south-east of the Kamaram field. Its area is nineteen square miles, the coal measures being found throughout about eight square miles. The groups represented are Kamthis, Barakars, and Talchirs. One coal seam was discovered, but, being much concealed, its thickness was not ascertained; an assay of a sample from it gave:—

Fixed carbon	62·4
Volatile	22·6
Moisture (6)	—
Ash	15
	100·

Additional seams, one of them 21 feet thick, have since been proved by boring.

This field may possibly become of some economic importance, as there is a prospect of there being a railway constructed at no great distance from it.

SIKKIM.

XXXI. Darjiling District.*

This field occupies a narrrow zone, which stretches along the foot of the Himalayas from Pankabari to Dalingkote. The rocks are probably Barakars, which have been much crushed and tilted, dipping at angles of from 40° to 90° to N.N.E., or towards the main mass of the hills. Frequently the sandstones have been converted into quartzites, and the shales into splintery slates. Much of the coal is in the condition of powder, and some of it has assumed the character of graphite. The effect of the compression has been to reduce it by removal of the volatile portions to the condition of an anthracite. Some experiments were made with a

* Mallet, "Memoirs Geological Survey of India," vol. xi. "Manual," vol. i.

view to utilizing it in the manufacture of artificial fuel, but the process found to be requisite was too expensive, and the difficulty of boring in these crushed rocks is so great as to render it improbable that this coal will ever be commercially available.

One seam is 11 feet in thickness. The average of five assays of the coal gives the following composition:—

Carbon	70·66
Volatile	9·20
Ash	20·14
	100·

Into a description of the complicated geological relations of these beds with those forming the adjoining mass of the Himalayas I do not now propose to enter. Mr. Mallet has arrived at the conclusion that the coal measures are older and underlie the highly metamorphic rocks of the outer slopes. To do justice to his arguments would require more space than is at present available for the purpose.

The fact that this locality is the principal one north of the Ganges where Gondwana rocks occur is of great interest in connexion with any discussion as to the early relations which existed between the Peninsular and Himalayan regions, and, indeed, the formation of the Himalayas themselves.

ASSAM.*

Five distinct coal fields have been explored and reported on in the valley of the Brahmaputra, in

* Mallet, "Mem. Geol. Survey of India," vol. xii. pt. ii. "Manual," vol. ii. p. 701.

the province of Assam. They are distinguished by the following names : — XXXII. Makum ; XXXIII. Jaipur ; XXXIV. Nagira ; XXXV. Janji ; XXXVI. Disai. Besides these fields there are also other coal-bearing tracts, the details regarding which have not yet been ascertained. It will be convenient in this abbreviated account to treat of them collectively.

Some uncertainty exists as to the age of the rocks, but the balance of evidence seems to favour the view that it is middle tertiary (Miocene), and therefore distinct from the cretaceous and nummulitic coals of the Khasi hills.

The coal differs from that of the Peninsular coal fields in having a homogeneous structure and in the absence of a laminated structure. The average of the assay of twenty-three samples gave :—

Moisture	5·
Carbon	56·5
Volatile	34·6
Ash	3·9

This indicates a high quality of fuel as compared with the coals of the Peninsular fields.

The opening up of these fields is a point of the highest importance, since at present coal is carried 1,000 miles from Bengal for the navigation of the Brahmaputra, this causing a ten-fold increase on the prime cost.

It is possible that some of the coal of the Khasi hills above alluded to may prove of value ; but the same does not seem probable in reference to the tertiary coals of the North-West Provinces, although hopes in that direction have often been expressed, and

a project for the exploration of one of these deposits has, I understand, recently assumed a tangible form, a company having been formed, the results of whose operations will be watched with interest.

Present Out-turn of Coal in India, and Importations of Coal from Foreign Countries.

An interesting Paper on the "Coal Importations into India," by Mr. Hughes, of the Geological Survey of India, was published in the year 1879.* I quote from it the following general remarks, but must refer to the original tables for details :—

Beginning with the year 1853, the shipments of coal and coke to India were 43,562 tons. Since then, after the lapse of a quarter of a century, they have risen to 609,735 tons. The ratio of increase has not been by any means steady; wars, rumours of wars, famines, and improved home freights have always exercised an irregular influence; as during the past two years, the importation having jumped from 399,887 tons in 1876, to 539,533 tons in 1877, and to 609,735 tons in 1878. Our main supply has hitherto been derived from the United Kingdom; the contributions furnished by other countries, with the exception of those from Australia and France, during spasmodic periods, being insignificant.

Australian coal has been imported since 1857, but the amount has fluctuated much from year to year; in 1858, 14,061 tons went to Bengal and 8,998 to Bombay. In 1874, 14,677 tons went to Bengal and apparently none to Bombay. In 1877, only 799 tons went to Bengal and none to Bombay, so that the trade is probably coming to an end.

* "Records of the Geological Survey of India," vol. xii. p. 83.

As Bengal has her own coal she imports less than Bombay,* the returns being :—

	1870.	1877.
Bombay. . .	239·651 . . .	368·937
Bengal. . .	42·433 . . .	76·278
Burmah . .	20·198 . . .	47·770
Madras . .	11·648 . . .	22·544
Sind . . .	1·995 . . .	7·855
	315·935 . . .	523·384
Add coke . .	21·088 . . .	16·149
	337·023 . . .	539·533

That a certain amount of foreign coal will always be in the Indian market is certain, since owners of outward-bound ships find it convenient to make use of it as ballast, and carried in this way it is sometimes sold at very low prices; thus, on one occasion English coal was quoted in the Calcutta market at sixteen shillings a ton, and it seldom, I believe, rises to much above £2 a ton. The trade in Indian coal between Calcutta and Bombay by sea is not yet fully developed, and it is uncertain whether it will ever assume such dimensions as seriously to affect the imports of foreign coal into Bombay.

In conclusion, it may be said that the annual consumption of coal in India, for sea-going and river steamers, railways, factories, domestic and other purposes, amounts now to upwards of one million-and-a-half tons, and that, in round figures, two-thirds of this amount is raised in the country and the other imported.

* I have (pp. 70, 86 *supra*) pointed out that there is a varying point on the railway where Bengal coal meets coal imported into Bombay at equal prices, their relative value as fuel being taken into consideration.

CHAPTER III.

GOLD.

THE subject of Indian gold is one of vast extent. Not only does the precious metal occur under varying circumstances over many more or less detached areas of country, but the methods of extraction practised by the natives seem to have originated long before the Christian era, and the out-turn gradually accumulated through long periods of time, even by such imperfect operations, may not impossibly account for the great stores of gold which, according to historians, were undoubtedly possessed by the Rajas in some parts of India formerly.

Thus there may be said to be two wholly distinct aspects of the question: I. The geological. II. That which belongs to the province of the antiquarian, historian, and political economist. It will be possible for me to allude only very briefly to the second aspect, since not only are many of the necessary works of reference inaccessible to me at present, but also because such a topic requires the hand of a specialist in that kind of inquiry for its adequate treatment.

The ultimate derivation of the gold throughout India is chiefly from the quartz veins which occur in the different series of more or less metamorphosed rocks which are recognized as existing in that country. I say chiefly, because I have reason to believe that in some localities gold is contained in certain chloritic schists, and possibly, too, in some forms of gneiss.

Proximately it is occasionally derived from rocks belonging to various formations which range from Permian through tertiary periods up to recent alluvial deposits. To some of the facts under this last heading, which will be found in the following detailed accounts, I would invite particular attention, as they are of considerable interest when placed in comparison with similar facts in other gold-producing countries.

Gold-washing, as practised in India, affords an example, I believe, of human degradation. The colonies of washers who are found plying their trade in most of the areas where, geologically speaking, the occurrence of gold is possible, must be regarded as the remnants of a people possessing special knowledge;* for although the former may have some acquaintance with the appearance of the rocks in the neighbourhood of which gold occurs, still, so far as I could ascertain from a close examination of the operations of two gold-washers who were in my service for about three months, such acquaintance, if possessed, is rarely availed of. Indeed I doubt if they ever look upon the rocks as being really the source from whence the gold has been derived. They know of its occurrence in the sands and alluvial soils, but whence it ultimately came from they do not trouble to consider.

But it cannot always have been so, for their earliest progenitors must have ascertained the existence of the gold by the application of experimental research

* I have often been struck with the traditional knowledge of such subjects as *materia medica* possessed by individuals of semi-savage tribes, who never seem to discover a new idea for themselves, nor to modify in the slightest degree, when uninfluenced by superior races, their method of performing any one single act in their domestic economy.

in localities where, from theoretical considerations, they believed it to exist.

It is scarcely possible that the non-gold-producing areas in which the Dekan trap or basalt and the rocks of the Vindhyan formation prevail, and which aggregate a total area of about one-fourth of the peninsula, were ever systematically prospected, and for this reason, if for no other, that the washers, if they were comparable to those of the present day, could not have devoted months and years to the exploration of, for them, barren tracts, simply from the fact that they could not subsist under such circumstances.

By what means, soever, they were led to select and settle in these gold-producing tracts, it is certain that within such limits a process of segregation has been going on towards the richest points.

In a part of Western Bengal* I found that generations of washers had demarcated limits within which washing was remunerative, and these limits corresponded in a striking degree to the well-defined boundaries between two formations—the metamorphic and the sub-metamorphic. In the area occupied by the former, gold was not absent, but its abundance as contrasted with that in the latter I ascertained, by two independent methods of calculation which are described below, was in the proportion of 1 to 3. Hence, as the washers only managed to eke out a bare subsistence in the sub-metamorphic area, they confined their operations to it.

The detailed accounts of Indian gold-producing tracts admit of the following geographical arrangement, proceeding from south to north:—

* *Vide infra*, p. 114.

MADRAS.
1. Wynaad, and 2. Kolar.

BOMBAY.
1. Dharwar, 2. Belgaum, and 3. Kaladgi.

BENGAL.
1. Central Provinces, 2. Orissa, 3. S.W. Bengal, 4. N.W. Provinces, including Himalayas and Punjab.

ULTRA-PENINSULAR AREAS.
1. Assam, 2. Burmah, 3. Afghanistan, 4. Thibet.

MADRAS.

WYNAAD DISTRICT.—The recent contributions to the literature of the gold-fields of the south-eastern portion of the Wynaad are so voluminous that I experience a difficulty in preparing a sufficiently complete epitome of their contents. Among these contributions the principal are the reports by Mr. William King, jun.,* Deputy Superintendent of the Geological Survey of India, and Mr. Brough Smyth,† who was specially deputed by the Government of India to explore and report upon the gold in Southern India.

The Wynaad forms a terrace of mountain-land intermediate in position between the low country of Malabar and the lofty plateau of the Nilgiri Mountains. It is separated into three portions, which are locally known as North, South, and South-East Wynaad; the latter portion has recently been transferred from the official limits of the Malabar jurisdiction

* "Records of the Geological Survey of India," vol. viii. p. 29, and vol. xi. p. 235.

† "Report on the Gold Mines of the South-Eastern portion of the Wynaad."

to those of the Nilgiri district, and in it the principal gold tracts are situated.

The principal rocks of the area are granites, gneisses, and other forms of metamorphic rocks, which are traversed by numerous quartz reefs.

In the tract to which Mr. Brough Smyth gave his particular attention, and which covers about 500 square miles, 200 out-crops, not necessarily distinct reefs, were counted; they are, in short, stated to be more numerous, and proportionately wider and richer, than in almost any part of Australia. Mr. King, first, and subsequently Mr. Brough Smyth, pointed out that throughout the area there are no accumulations of drifts or deep leads covered by volcanic formations such as characterize the Australian fields. Operations, therefore, have been hitherto, and must be in the future, confined to "surfacing" and quartz mining, a regular hydraulic system of mining being inapplicable.

By all the authorities it is considered that the native processes of washing, as practised to-day by the Korumbas and Moplas, is of high antiquity, dating as far back as 500 years B.C. There is evidence, however, that operations were not limited to mere washing, but that mining was carried on by one or more classes of people who have no representatives at the present day. Mr. Brough Smyth enumerates the traces of this higher skill under the following heads :—

1. Quarrying on the outcrops of the veins.
2. Vertical shafts.
3. Adits.
4. Vertical shafts with adits.
5. Shafts on underlie.

And remarks that they show different degrees of knowledge of the miner's art.

The vertical shafts, though not considered to afford evidence of the highest degree of mining skill, offer a problem difficult of solution. They are, even when in solid quartz, sometimes 70 feet deep, with smooth sides and quite plumb; what the tools were which enabled the miners to produce such work in hard dense quartz no one appears to be able to suggest. The fragments of stone obtained from these various mines were pounded with hand mullers, the pounding places being still seen, and the pounded stone was then, it is believed, washed in a wooden dish and treated with mercury.

The Korumbas or gold washers, who are admitted to be skilful, do not regard the gold as being derived from the reefs, though they generally select spots near the reefs for washing. Their earnings amount to from two to three annas (3*d.* to 4½*d.*) a day, but it is possible that at an earlier period of the industry it may have been more profitable, since Mr. Brough Smyth says that the present condition of the country is, that it is covered with "tailings," and corresponds to that of an abandoned Australian washing. Still it is the case that:—

> On washing a few dishes of the surface soil anywhere a few streaks of very fine gold will be found. In the vicinity of the reefs rather heavy gold is got by sluicing; and if a suitable spot be selected the native miners will obtain, even by their methods, sufficient gold to remunerate them for their labour.

I cannot quote here a tithe of the evidence which exists as to the former wealth of Southern India, but the following extract from a letter by Mr. E. B. Eastwick will be read with interest. Mr. Eastwick quotes from Dr. Burnell:—

It has always been a puzzle whence the great wealth came which enabled the Rajahs of Southern India to construct enormous works, which collectively must have cost millions. The marvel is increased by the fact that, so far from these Indian princes having been impoverished by this expenditure, they were still possessed of vast treasures, which fell into the hands of the Moslems in the fourteenth century and were carried away to Delhi. The famous Tanjore Temple inscription speaks of a great abundance of gold which can only have arisen from mines. Dr. Burnell writes:—"It proves that in the eleventh century gold was the most common precious metal in India. Silver is little mentioned, and it thus appears that the present state of things, which is exactly the reverse, was only brought about by the Portuguese in the sixteenth century. I submit that the great abundance of gold spoken of in the inscription can have arisen only from mines, and that in the terrible convulsions caused by the irruption of Moslem invaders from the north, and Europeans from the west, the position of these gold fields was lost sight of."*

The History of Tippoo Sultan further gives definite accounts of vast accumulated treasure in gold.†

To my mind, as an occasional visitor to the Madras Presidency, there is a noteworthy and remarkable fact which seems to have been overlooked by writers on this subject, and that is that the total amount of gold in the possession of the poorer classes of the inhabitants of Southern India must be enormous, and proportionally much greater than in other parts of the

* Times, January 2nd, 1879.

† It may be well to point out that gold working in these early times was in all probability carried on by slave labour, or what amounted very much to the same thing, and that peculation met with pretty summary treatment.

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country. Men, women, and children even of the coolie class are commonly to be seen wearing ornaments of pure gold. Golden nose ornaments are worn almost universally by the women and children. In the northern parts of India the ornaments which are worn are generally made of the baser metals or of glass, &c. In times of famine or distress in Southern India these golden ornaments are disposed of in order to procure food. Throughout India the use of jewellery by the higher classes is sufficiently notorious not to require special comment; but the use of pure gold by the lower orders is in a great measure, I believe, peculiar to Madras.

In the year 1831, the Government appointed a Commission to make inquiries into the gold-yielding district of the Wynaad, but the matter was for a time allowed to drop. During the last decade, however, largely in consequence of the number of Europeans attracted to the coffee plantations, interest in the subject was again aroused, and several pioneer companies were formed; but although favourable percentages were obtained by assays the practical results of quartz crushing were counted only in pennyweights per ton, and owing to defective management and imperfect machinery, the time expended, and consequently the cost of production, proved greater than the receipts.

Mr. Brough Smith is of opinion that if proper care be taken under skilled management the working of gold in Southern India must ultimately become a profitable undertaking :—

The average yield out of 137 samples assayed was 2 oz. 13 dwts. 2 grs. per ton, or, if one exceptional sample,

which yielded 204½ oz. and another which gave 25½ oz. to the ton be left out, the average yield was 1 oz. 8 dwts. 22 grs. per ton.

At the present time (May, 1880) there are two or more companies in London, one in Glasgow, and several in India, which have for their object the working of mines in the Wynaad, and it is said that already favourable news has been received of the preliminary operations, and the shares are now quoted at a high premium.* As I ventured to predict in my recently-published work, "Jungle Life in India," when speaking of mining enterprise generally in India, some of the undertakings seem destined to be hampered seriously, on the threshold of their operations, by vexatious litigation, which is in part due to the absence of definite mining laws in India.

The following, which I extract from the *Pioneer Mail*, of the 22nd of April last, is the very latest information I have received on this subject:—

Since public interest in the gold-mining prospects of Southern India waxes stronger day by day, both at home and in this country, and men have made up their minds that the development of vast mineral wealth is merely a question of time, capital, and machinery, it is discouraging to hear that enterprise is likely to be checked in certain parts of the Wynaad in consequence of litigation. This has been anticipated for some little time. It was known that the right of ownership of certain blocks was challenged, and that the dispute was likely to culminate in legal hostilities. It is now currently reported that the

* Extract from William Abbott's Monthly Price List, dated 6th May, 1880. Indian Glenrock Gold Mine—Capital £100,000, Shares £1; Paid all; Price £1⅜–1⅝. South Indian Gold Mine —Capital £100,000, Share £1; Paid all; Price £1¾–2.

"fat is in the fire," and that actions and cross-actions are pending. If this rumour prove true, work will of course be brought to a deplorable stand-still, and the general high opinion formed of the field at home will suffer. Nothing could exercise a more deterrent effect upon the minds of English speculators than to hear that the legal title to the land was doubtful. For this, and indeed for every reason, the best endeavours will no doubt be made to settle ground-right disputes by arbitration, and to preserve "peace with honour" among the various claimants.

I am tempted to add the following extract from the *Pioneer* also, which illustrates the shortsighted policy of the native landholders, and the manner in which they can in India—unrestrained by such regulations as exist to limit the powers of landed proprietors in Australia—effectively cripple mining enterprise :—

The Ootacamund paper learns that "the Nellambur Raja is determined to make those who want the mining rights on their coffee estates pay well for them, and all this comes out of the Alpha lease having been extended for a large sum of money, some Rs. 10,000, for ten acres of land, the vein stone of which, it is expected, will be worked out before the present lease, some eight years more, expires. It appears also that the mining concessions lately acquired by the trustees of Messrs. W. Nicol and Co. limit them to the selection of fifty acres within a certain area of his territories, and that owners of estates within these boundaries are not to be interfered with. The Raja has offered to grant mining rights to all desiring them, but upon terms which will simply drive away capitalists. We certainly think a deputation of the Raja's tenants should wait upon His Highness and impress upon him the folly of demanding such exorbitant and prohibitive rates, or making them sign agreements which can never be fulfilled."

The question of climate is by no means an unimportant one, and has not been overlooked by Mr. Brough Smyth. It is a factor known to exercise an appreciable influence in all commercial undertakings in India, as, for instance, the cultivation of tea in Assam :—

Though the climate of the Wynaad has been represented as unhealthy, it is not uncommon for Europeans employed in connexion with coffee gardens to remain in the district with their families throughout the whole year. Fever is prevalent in March, April, and May, and some of the residents become seriously ill. But it must be borne in mind that a coffee-planter who attends carefully to his business is subjected to exposure to the sun during the hot months and to the heavy rains during the monsoon. He has to walk or ride for many hours each day, when the solar radiation is at its maximum, and during the monsoon his clothes are rarely dry.

KOLAR (OR COLAR) DISTRICT.—The Kolar district, situated in Mysore, is also at the present moment attracting a considerable amount of attention in connection with its gold. Unlike the Wynaad it does not appear to have been as yet systematically explored by any geologist or mining expert, and my information regarding it is therefore limited to what I have been able to collect from notices in the Indian newspapers. However, the general fact is known that the rocks are similar to those of the Wynaad, belonging to the metamorphic series, but as to the abundance of quartz reefs I have no information. As in the Wynaad, gold has long been sought for by the natives in Kolar, and it is claimed for this area that it was largely instrumental in supplying the wealth of Southern India spoken of above. Indeed, it is stated that Hyder

and his son Tippoo erected their mints, the ruins of which are to be seen to this day, in the district close to the spot where the Ooregaum Company is at present working. The climate is said to be good, quite equal to that of Bangalore, the elevation being 3,800 feet above the sea, and the arrangements made by the Government for leasing the land are described as being favourable to enterprise. The following extract is from the *Pioneer* of the 29th of April, 1880 (quoting the *Bangalore Spectator*):—

GOLD MINING IN MYSORE.—From a notice issued by Messrs. Arbuthnot and Co. it appears that a company is being formed to work a portion of the land in the gold-yielding region of Ooregaum, in the Kolar district. The Ooregaum Company is now hard at work, and the analyses of quartz from its mines, by Mr. Brough Smyth, show conclusively that the auriferous yield is exceedingly good, and that the results to be obtained are all that can be desired. The gold-fields are not far from the Colar Road Station (six miles) and have everything in their favour—climate as good as Bangalore, food and labour cheap and plentiful, and there is every reason to believe that the gold-mining industry will be a great success in the Mysore country. Those who wish to invest in a good speculation have now such an opportunity placed within their reach, while the well-known name of Messrs. Arbuthnot and Co. is a sufficient guarantee that the Madras Gold-mining Company will be carried on properly. Judging by our English contemporaries, it would appear that there will be no difficulty in allotting the whole of the shares in the London market, where the gold mining companies are highly thought of as safe investments.

BOMBAY.

Within the limits of the Bombay Presidency the districts of Dharwar, Belgaum, and Kaladgi are the

principal in which gold is known to exist, and where native gold-washers, locally called *Jalgars*, derive a livelihood from searching the auriferous sands.

DHARWAR DISTRICT.—In a Paper entitled "The Auriferous Rocks of the Dambal Hills, Dharwar District,"* Mr. R. B. Foote, F.G.S., of the Geological Survey of India, has given an account of his researches when tracing the source from whence the alluvial gold of the region has been derived, together with a description of the system adopted in washing for gold in the streams which flow through the auriferous tracts.

Mr. Foote considers that the gneissic rocks of this area belong to three distinct series, each characterized by certain lithological peculiarities. He distinguishes them by the following local names:—1. Dhoni, 2. Kappatgode, 3. Soortoor:—

All the streams said by the natives to be auriferous rise within the limits of the tract occupied by the Soortoor series, and the upper course of the Soortoor Nullah. The richest of all lies entirely within the area occupied by the pseudo-diorite and associated chloritic schists.

"Quartz reefs occur in all the rock series above enumerated, but those lying within the limits of the Soortoor series are the best defined. . . . . The surface of the principal reefs has been much broken up, doubtlessly by gold seekers.

Mr. Foote obtained a trace of gold in a fragment of quartz from the principal reef in the Kappatgode series.†

* "Records Geological Survey of India, 1874," vol. vii. p. 133.

† Other authorities on this region are, as quoted by Mr. Foote —Lieutenant Aytoun, "Trans. Bombay Asiatic Society," vol. xi. p. 8; Dr. Carter, "Geological Papers on Western India;" Capt. Newbold, No. 4 of "Papers on the Mineral Resources of Southern India."

BELGAUM DISTRICT.—Mr. Foote (*loc. cit.*) mentions several localities in this district where gold was formerly washed for, or was reported to occur, in the sands of various streams. It appears to have been derived from quartz reefs which traverse some chloritic schists and pseudo-diorite. In certain localities gold is still obtained in small quantities, but the district does not appear to be one of much promise.

The gold-washers (*Jalgars*) are stated to be Mahomedans, which is exceptional, probably they are converts.

In reference to this district Mr. Foote* has also written a follows :—

Gold is found in very small quantities in some of the streams flowing into the upper part of the Malprabha, from both sides, through a region occupied by chloritic schists, with rather poor hæmatite schist intervening.

The exact source of the gold supply remains to be determined. The yield is so exceedingly small that these streams are now but very rarely visited by the *Jalgars*, or gold-washers. Very few quartz veins occur in this region, and none were noticed with a north to south course. A small stream a little westward of the village of Belowaddi appears to be the most auriferous, but I failed in getting an appreciable quantity of gold in a number of carefully-selected samples of sand and gravels collected in promising places in the bed.

BENGAL.

Using the term Bengal in its widest acceptation the gold-producing areas included in it may be classified as follows :—

1. Central Provinces.
2. Orissa.

* "Memoirs Geological Survey of India," vol. xii. p. 259.

3. South-Western Bengal, or the Chutia Nagpur Province.

4. North-West Provinces, including the Himalayas and Punjab.

1. CENTRAL PROVINCES.—In the extensive region known as the Central Provinces, and throughout a considerable portion of which metamorphic rocks prevail, gold-bearing rocks and their natural product, auriferous sands, are probably widely distributed; but on this subject little has been published, and at present I am only able to refer to a Paper by Colonel Ouseley,* and to my own notes which apply to the district of Sambalpur, where I made inquiries regarding gold in connection with those which I instituted in the same locality in reference to diamonds.

The following remarks I have already published,† but I reproduce them here only slightly modified, as they serve to epitomize all that is at present known on the subject.

Gold in all probability occurs pretty generally throughout those portions of the district of Sambalpur in which metamorphic rocks prevail. So far as I have been able to gather from personal observation, the washers confine themselves to the beds of the Mahanadi and Ebe; but in the rains they are said to leave the larger rivers and wash in the small jungle-streams.

In the Ebe, below Tahood, I saw a party of gold-washers encamped on the sand. The places where

* "Journal Asiatic Society of Bengal," 1839, vol. viii.

† "Records of the Geological Survey of India," vol. x. p. 190; and "Jungle Life in India," p. 529.

they were actually washing were within the area occupied by rocks of Talchir (Permio-triassic) age; but whether the gold was proximately derived from them, or had been brought down by the river, as is possible, from the metamorphic rocks a short distance higher up, I am unable to say.

There is, of course, no *primâ facie* improbability in the Talchir rocks containing gold. On the contrary, the boulder-bed, including as it does such a large proportion of materials directly derived from the metamorphic rocks, might naturally be expected to contain gold. In this connection it may be mentioned that in Australia, a conglomerate bed of carboniferous age has been found to be auriferous,* and the same has been recorded in Nova Scotia.†

As to the methods employed by, and the earnings of, the gold-washers, the remarks about to be made on the gold of Singbhum apply equally to Sambalpur, and need not be anticipated here.

It may be added that to the north-west of Sambalpur there are a number of parallel quartzite ridges which, in places, have much the appearance of veins; they are, I think, worthy the attention of the prospector for gold.

Fine quartz reefs also occur in many parts of the district.

ORISSA.—In the province of Orissa gold is reported to occur in the sands of the river Brahmani, in the Pal Lahara, where it is said to be worked to a considerable extent.‡

* *Vide* "Geol. Mag.," 1877, p. 286.

† "Jour. Geol. Soc.," vol. xxxvi. p. 313.

‡ "Mem. Geol. Survey of India," vol. i. p. 88.

Similarly, it is believed to exist in various rivers in the native States of Dhenkenal and Keonjhar.*

The above rivers drain areas in which metamorphic rocks are alone believed to prevail; but the already-quoted memoir, however, contains the following passage, which may be read in connection with the passage above as to the occurrence of some of the gold in Sambalpur:—

Gold is occasionally washed in the Tikaria river, and was also, a few years since, obtained from the sands of the Ouli. The latter case is rather interesting, since the localities are in a sandstone country through which the Ouli mainly flows.

SOUTH-WESTERN BENGAL, or THE CHUTIA NAGPUR PROVINCE.—In giving an account of this area I think it well to quote in full a Paper† by myself, which records the results of my researches in the districts of Singhbhum and Manbhum.

I do so because I believe this area has not received the attention from prospecting companies which it deserves. In the neighbourhood of Chaibassa, the chief town of Singhbhum, I have been especially struck with the auriferous aspect of the rocks. The earthy slates and shales with magnesian schists, and numerous small quartz reefs, are precisely the rocks which, judging from all experience, ought to yield gold:—

The existence of gold in the districts of the south-west frontier of Bengal and in the neighbouring tributary States has long been known. It is found not only in the sands

* Sterling, "Asiatic Researches of Bengal," 1825, vol. xv. p. 163.

† "Records Geol. Survey of India," vol. i. 1869.

of many rivers and streams, but in some instances it has been mined for in the alluvial and other superficial deposits.

Colonel Haughton, in his interesting memorandum "On the Geological Structure and Mineral Resources of the Singhbhúm Division,"* has given an account of the gold washing, and enumerated several localities where gold mining had been, or was at the time of his visits, carried on. He also quotes from a letter from Mr. Robinson, in which that gentleman states the results of his attempts to establish gold-mining under European superintendence. At Rabkobe, in Udipur, where operations were commenced and showed some prospects of being fairly remunerative, the climate proved so "hot and unhealthy" that it was found that no European could live there, and the works were given up.

Colonel Haughton says that "the metal was found some years ago in considerable lumps in the Sona Nuddee of Sonapet, in Tamar, on the the northern extremity of Singhbhúm, and much is still found there." I have invariably found that the washers have traditions of nuggets having been found at intervals. A nugget from the native State of Jushpur is now in the Geological Museum. Its exact weight was, after cleaning, 199·6 grains, the per cent. composition being—

Gold	94·64.
Silver	5·15.
	99·79.

The cases of gold having been found *in situ* are undoubtedly rare. Colonel Haughton speaks of its occurring *in situ* "a little north of Assuntulea in Khursowa," but farther on he states, "I have not heard of any instance in which the metal has been found attached to a stone," so

* "Jour. Asiatic Soc. Bengal," vol. xxiii. p. 103. 1854.

that the former statement must only mean to imply that it is mined for in superficial deposits. Dr. Emil Stoehr states* that traces of gold were found in the copper ores of Singhbhúm. A Mr. Emerson was specially employed by the Singhbhúm Copper Company to investigate the gold resources of the country. He is said to have crushed a quantity of quartz and to have found traces of gold in it; but his operations do not appear to have been sufficiently successful to encourage him to continue. In Chaibassa, I was shown a small nugget of gold in a quartz matrix. It was said to have been obtained in the Kappargadi Ghat, near Kalkapur, in Dhalbhúm.

It is not within the scope of the present Paper to write a complete *résumé* of all that is recorded on the subject, but rather to give an account of what has actually come under my own observation in those portions of the districts which have been examined geologically.

During the season of 1866–67, I fancied that I was able to connect the occurrence of gold in the streams with the existence of certain sub-metamorphic rocks (magnesian and mica schists, slates and quartzites) which were then for the first time met with in Mânbhúm. Being anxious to put this connection to as rigid a test as circumstances would admit of, and wishing to define, if possible, the exact boundaries within which gold certainly exists and may be reasonably looked for, I with some difficulty persuaded two gold-washers (man and wife) to accompany me during my examination of the southern portion of the district of Mânbhúm. They remained with me for upwards of three months, washing daily at such places as were pointed out.

One of the most interesting results is, that the existence of gold in the metamorphic as well as the sub-

* Einige Bemerkungen über den District Singhbhum in Bengalen : *Vierteljahrschrift der naturforschenden Gesellschaft*, Zurich, 5th year, Part 4, 1880.

metamorphic rocks has been satisfactorily proved. This, from various reasons, I was not prepared to expect. Colonel Haughton, who speaks of the granitic gneissose rocks as *igneous*, states that gold is never found in the streams traversing them. Again, the natives, so far as my experience goes, do not wash the sands, &c., lying on these gneissose rocks, although they do not connect the existence of gold in the sands with the vicinity of any particular rock.

In Mânbhúm, the experience of generations of washers has enabled them to define the boundaries within which washing is remunerative; and this boundary, it is interesting to observe, corresponds on the north exactly with that of the sub-metamorphic rocks.* This coincidence I ascertained in the following manner. On my arrival at Dulmi (which is situated on the faulted boundary of these two groups of rocks) when marching northwards from the lower part of Patkum, the gold-washer asked to be allowed to return to his own country (Dhalbhúm), stating that none of his race ever went north of Dulmi. I induced him, however, to stop, and while we remained north of the fault the washings were carried on in the granitic gneiss area with comparatively poor, but not exactly barren, results. On the day I crossed the fault south of Sindaree, when returning southwards, the gold-washer said that we should after that find gold more regularly and in greater quantities than we had done since we came north at Dulmi.

During the whole time, a record was kept of the daily results and of the nature of the rocks in which the washings were made. The following abstract will suffice for comparison of the productiveness of the two formations :—

* A line drawn across the southern part of Mânbhúm from Simlapal on the east through Burrabazar to a little north of Echagurh on the west, roughly indicates the position of the line of boundary between the two formations.

SUB-METAMORPHIC OR LOWER TRANSITION SERIES.

——	Jan.	Feb.	March.	April.	Total.
Number of days on which washings were made	31	9	18	8	66
Unsuccessful days	2	3	2	2	9 = 13·6 per cent.
Gold in grains .	17·68	4·65	7·6	2·45	32·38
Daily average in grains . . .	·57	·516	·4	·3	Daily average for whole period $= \frac{32·38}{66} = ·49$ grs.

METAMORPHIC OR CRYSTALLINE SERIES.

——	Jan.	Feb.	March.	April.	Total.
Number of days on which washings were made	—	20	13	—	33
Unsuccessful days	—	13	9	—	22 = 66 per cent.
Total gold in grains . . .	—	4·78	·7	—	5·48
Daily average .	—	·23	·05	—	Daily average for whole period $= \frac{5·48}{33} = ·16$.

Comparing the results by the number of successful days first, we may say, that for gold-producing, the sub-metamorphic rocks are to the metamorphic as (100—13·6=) 86·4 to (100—66=) 34=2·5 : 1 ; comparing by daily average, the proportions become ·49 : ·16=q. p. 3 : 1. We may therefore conclude that the sub-metamorphics are between two-and-a-half and three times as productive of gold as the metamorphics, so that as the gold-washers only find a subsistence from washing in the sub-metamorphic area, it is obvious that it would not pay them to work in the metamorphics.

The greatest amount found on one day was 2·2 grains, but the daily averages given above should not be taken as indicative of the amount of gold to be found by a regular system of working, where the washers would of course be set at favourable spots, and would not have to spend a considerable portion of their time daily, as was the case of the men I employed, in making marches before they reached the scene of their labours.

It is conceivable that the fact of the greater quantity of gold being found in the superficial deposits within the sub-metamorphic area might be attributable to something in the configuration or elevation of the ground conducive to the greater accumulation of gold within that area. I could not, however, discover anything of this kind; the fall to south is gradual throughout both formations. The origin of the gold which is annually found in the rivers at present is, I believe, twofold, a portion being directly derived from the rocks, and the remainder resulting from the reassortment of detritus which is the remnant of sub-aerial action. In both formations, the evidences of extensive sub-aerial action are numerous and prominent, and it is obvious that Nature has been carrying on gold-washing operations in the valleys since denudation first commenced to scoop them out, leaving barriers of intervening ranges of hills formed of the hardest rocks between them.

Various Papers in the "Asiatic Society's Journal" describe the methods of gold-washing practised in different parts of India. The instruments used, though essentially the same in principle throughout, have local peculiarities of shape, &c., and the manner of manipulation also varies. At Hira Khund, in Sambalpur,* the same instrument and manipulation served for the separation of both diamonds and gold. In fact the diamonds were found in the middle of the process, the iron sand with specks of gold being the final residue. In Mânbhúm and Singbhúm the instruments used are, perhaps, more simple than those used in

* "Jour. Asiatic Soc. Bengal," viii. 1057. 1839.

any other place. The dish measures 28" by 18", it is hollowed somewhat eccentrically to a maximum depth of about 2½ inches. A scraper, formed of a flattened iron hook set in a handle, serves to collect the auriferous sand and gravel which accumulates in the angles of the rocks in the beds of streams. The dish when filled is placed in shallow water, and the operator working with his hands soon separates and throws aside all the coarser gravel and stones, while the agitation of the water serves to carry away all the mud and lighter portions. The dish is then balanced on the palm of the left hand and oscillated to and fro with the right; this serves to throw off the greater portion of the remaining gravel, and the process is completed by a circular motion, which is communicated to the water in the hollow of the dish, by which even the smallest particles of foreign matter are separated, and the final result is a residue of black iron-sand in which the specks of gold are readily apparent.

The gold-washers belong to the lowest and poorest races in the country. Throughout Chutia-Nagpur the tribes who are engaged in this occupation may be classified as follows:—

1st.—The Dohras, or Dokras, of Mânbhúm, who are allied to the Kumars, and profess to be Hindus. Among them both sexes wash for gold.

2nd.—The Ghasis of Singhbhúm, among whom the men only wash for gold. The Ghasis are also musicians, and only certain families, or sub-tribes, engage in the former occupation.

3rd.—In the hilly country, west of Singhbhúm, among certain of the Kol or Munda tribes, the women wash for gold during the rains; but the men regard the occupation as unworthy work for their sex.

The methods employed by these different tribes appear to be identical in all essentials, and similar to the process just described. Each occupies a distinct tract, and poaching on each other's favourite streams is not indulged in to any great extent.

Their numbers were greatly reduced by the famine of 1866; without exception they are all in the power of the money-lenders, for whom they work at a low rate, and are never able to free themselves of the claims which the latter make on account of advances.

The daily earnings of the gold-washers are small, but might, no doubt, be increased, if it were not that they are always satisfied when enough gold has been found for procuring the day's subsistence.

Colonel Haughton says:—"The Ghasis can always reckon on earning three or four pice per day, and I am assured that a vigorous man often gets as much as twelve annas, which, as the ordinary rate of field labour is about one pice, must be considered a very large sum."* Mr. Robinson found, in a trial which he made at Raobbk, in Oodipur, that men to whom he paid one anna could produce for him from three to four annas worth of gold. Colonel Dalton states that the washers themselves regard it as a very poor trade, simply yielding they say, *pét bur* (bellyful). Dr. Stoehr, in his Paper on Singhbhúm, states that he found the average daily earning to be about 25 centimes (rather more than an anna and a half). The men I met with stated that they could earn about an anna a day, and occasionally three or four annas.

The simplest idea of the process of hydraulic mining which seems so nearly to approach to perfection in California, is not altogether unknown to the natives. Mr. Robinson says:†—"Another plan, and a very remarkable one, in which the people collect the gold, is by drawing up small watercourses before the rains, so as to make places for a deposit of soil carried down by the water; this soil is cleared out several times and in it is found a large deposit of gold."

In the shallow diggings the hydraulic system would not, of course, be applicable; but even in them an in-

* "Jour. Asiatic Soc. Bengal," vol. xxiii. 1854, p. 109.

† *Ibid.*, p. 108.

creased yield would undoubtedly result from supplanting the native's dish by the Californian pan, rocker, long-tom, and sluice.

North-West Provinces, including the Himalayas and Punjab.

In the North-West Himalayas the occurrence of gold has been alluded to by many travellers, but the following notices, from the official publications of the Geological Survey of India, contain the most important facts in connection therewith :—

There are gold-washings carried on yearly in the beds of the Himalayan rivers, and most extensively even in streams which only drain the sub-Himalayan rocks. The fact is rather interesting; since in these streams the gold must have a doubly derivative origin.*

Sona River, Gurhwal District.—This stream rises in the lower range of hills, and joins the Ramgunga river in Paltí Dhún. Its sands yield gold, and the bed of the Ramgunga below the junction is auriferous. The washing is not very profitable, scarcely averaging four annas a day to each workman.

Again :—

The sands of the Ganges, running through Taluka Chandi, contain gold, but the profit arising from the washing is not greater than in the Sona river.†

Punjab :—

Gold is washed for in the Indus, at Kalabagh, sometimes also in the Bunhar river bed at the other end of the range (Salt Range), and in several small streams along its northern flanks, *the present source of the precious metal* being the tertiary sandstone formation,

* Medlicott, "Mem. Geol. Survey of India," vol. iii. p. 179.

† Lawder, "Records of the Geological Survey of India," vol. ii. pp. 88, 90.

and apparently among the lower beds of the Lower Siwalik group. The process is not continuous, being only carried on after heavy falls of rain in the smaller streams, and in the Indus when floods permit. The amount realized can hardly be closely ascertained, for as the industry is taxed it is the interest of the operators to conceal their gains. According to the best information obtainable these fluctuate from three to four annas' worth a day per man, this being generally thought rather above the measure of success.*

The gold washing in the Salt Range is described in some detail by Dr. Fleming in his Report.†

Dr. Jameson also alludes to the gold which is found there.‡

Ultra-Peninsular Areas.

The principal gold-producing countries beyond, but adjoining the limits of, Peninsular India, are on the east :—

1. *Assam.*
2. *Burmah.*

And on the west and north :—

3. *Afghanistan.*
4. *Thibet.*

Assam. — In Assam Capt. Dalton and Col. Hannay carried on researches, in reference to the occurrence of gold, which were made public through the medium of the "Journal of the Asiatic Society of Bengal."§ Subsequently the same gentlemen were requested by Government, in the year 1855, to undertake a farther examination of the auriferous deposits

* Wynne, "Mem. Geol. Survey of India," vol. xiv. p. 303.
† "Jour. Asiatic Society Bengal," 1853, p. 230.
‡ *Ibid.*, vol. xi. p. 1.
§ Vol. vii. p. 625, and vol. xxii. p. 511.

of Upper Assam, and were supplied with ample funds for carrying out their investigations.

From an abstract of their reports, by Dr. T. Oldham, late Superintendent of the Geological Survey of India, I quote the following:*—

Gold was obtained in the Brahmaputra at Parghat, above Sudya, and in several tributaries, Noa-Dehing, Dihong, and Hookong. "The spots selected by the natives are those salient angles or reaches of the river where the alluvial deposits, cut away by the stream from the opposite bank, are partially redeposited, after having undergone the sifting action of the current."

The gold "is derived from the crystalline rocks in the first instance, but only becomes sufficiently concentrated to render it worth working in the alluvium, after this alluvium has undergone repeated washings in the river current, by being successfully cut away, washed, and re-deposited as the river changes its course."

The Dihong river, from the hills to the north, "yielded gold in considerable quantity, from its junction with the Brahmaputra to about half-way between that stream and the hills." $5\frac{5}{7}$ tons of gravel yielded 90 grains of gold = $16\frac{1}{3}$ grs. per ton. "This stream is considered by the natives to be the richest in Assam."

The apparatus used in these investigations were a Californian cradle worked by four men, and which was found to give the largest daily yield per man; and a Singpho washing dish worked by one washer and one assistant.

No. 1. Gold from Brahmaputra yielded		88·281	per cent.	pure gold
No. 2. Noa Dehing	,,	93·880	,,	,,
Dihong	,,	90·234	,,	,,
Hookong	,,	86·588	,,	,,

BURMAH.—The following facts are taken from a

* "Mem. Geol. Survey of India," vol. i. p. 90.

Paper, by Dr. Oldham, entitled "Notes on Specimens of Gold and Gold Dust procured near Shue Gween, in the province of Martaban, Burmah."*

Gold-bearing sands and nuggets were forwarded from Shue Gween to Dr. Oldham, who obtained from the former, amounting to about the fifth of a cubic foot in bulk, ·75 of a grain of gold by washing and ·20 by the aid of mercury = ·95. The sand consisted of particles of metamorphic rocks. The gold on assay proved to consist of 92 per cent. of pure gold and 8 per cent. of silver.

The natives washed in the Shue Gween river from time immemorial, and under the Burmese Government there was a Farmer-General who paid a certain sum to the royal treasury and sub-let the privilege of washing to numbers of persons.

Mr. Theobald, of the Geological Survey, writes as follows regarding gold in the Irrawadi:†—

Gold occurs in the bed of the Irrawadi, but in such fine dust and so sparingly that few engage in the task of washing for it. I am told that it is occasionally washed before Prome, but the only spot where I have witnessed the process is at Shuaygyeing (gold scratching), not to be confounded with Shuay Gyeen on the Sittoung, just above Monyo, where a little gold is obtained. The gold is found in a coarse gravel bank, left dry by the river when it subsides after the rains.

This coarse gravel is dug out and laid on a sort of hurdle, which permits the fine sand to pass through, the coarse pebbles and boulders being rejected. This sand is washed on an inclined board; the lighter portion being gradually swept down the incline by a stream of water directed over it, whilst the heavy auriferous sand remains, and is from time to time collected. The sand is lastly

* "Mem. Geological Survey of India," vol. i. p. 94.
† *Idem*, vol. x. p. 343.

washed in the common wooden hand dish, of circular form, and the gold it contains *collected by amalgamation*. The profits of this pursuit are small, and the labour great; the men not netting more than two or three annas a day profit, which must be regarded as a miserable remuneration, where the ordinary hire for a cooly is eight annas, or twice that at the rice ports during the shipping season.

In another Paper, on the "Metalliferous Resources of British Burmah," Mr. Theobald says:*—

Though of slight economic importance, gold occurs in most parts of Burmah, but is very little worked within British territory, which I attribute to the higher and more certain remuneration there obtainable for agricultural or other labour; and gold working is therefore pursued mainly in bad seasons, or as an exceptional means of industry taken up merely now and again.

Tavernier,† in his enumeration of the places where gold is produced in Asia, mentions the kingdom of Tipra (? the modern Tipperah). He says, "it is coarse, almost as bad as that of China."

Other references to the gold of Burmah are to be found in various works descriptive of that country.

AFGHANISTAN.—There is a gold mine a little to the north of Kandahar city. It appears to be in quartz veins, which are superficially excavated, gunpowder being employed. The gold is sometimes chiselled out in pure granules; the stone is not taken out unless it contains visible gold. It is taken into the city for treatment. The mine belonged to the Government; had been worked anyhow for some twelve years, and in 1872 was leased to a contractor for Rs. 5,000 a year. As much more was spent on working the mine, and the yearly out-turn was said to exceed Rs. 10,000.

* "Records Geological Survey of India," vol. vi. p. 95.

† "Travels."

THIBET —I include Thibet in this account as there is every reason to believe that for many centuries a regular supply of gold has entered India from thence, and continues to do so to the present day. In a Paper by Mr. A. Lawder, on the "Mineral Statistics of the Kumaon District,"* we find the following passage :—

Gold is found in many of the rivers of Thibet, at Silungsakka, &c. ; it is sold at the same fairs as the salt and borax, either in nuggets or grains. About 10 to 12,000 rupees' worth is brought down annually, some of which is disposed of in the hill districts (Kumaon and Gurhwal), probably about one-third, and the remainder most likely finds its way to Delhi, Agra, &c. It is sometimes found to contain copper.

Tavernier† mentions the occurrence of gold in Thibet, though he was not aware apparently of its being worked in his time in Southern India. He says :—

Toward Thibet, which is the ancient Caucasus, in the territories of a Raja beyond the kingdom of Cachemir, there are three mountains close one by another, one of which produces gold, the other *granats* (garnets), and the third lapis lazuli.

Of the very highest interest are the accounts of the Thibetan gold mines which are given by the Pundits attached to the Indian Survey for the purpose of exploring countries north of the Himalayas. Unwittingly these admirable native servants of the Government of India have furnished facts which have enabled Sir Henry Rawlinson, and independently

* "Records of the Geological Survey of India," vol. ii. p. 90.
† "Travels."

Professor Frederic Schiern, Professor of History at the University of Copenhagen, to clear up a mystery which has been a puzzle to the historians and philosophers of many countries for upwards of 2,000 years. A translation of Professor Schiern's Paper,* by Anna M. H. Childers, will be found in the "Indian Antiquary."† It is a most remarkable example of learned research, and one very difficult to give in abstract. It is entitled "The Tradition of the Gold-digging Ants." But perhaps before giving the conclusions which Sir Henry Rawlinson and Professor Schiern have arrived at, it will be best in this place to briefly describe the Pundits' observations :—

During the expedition of 1867 the Pundit who had been at Lassa fell in at Thok Jarlung, an important gold field in the province of Nari Khossam, with a large encampment of Thibetan miners, and took the opportunity to gain information relative to the working of the mines. In the third expedition, in 1868, another Pundit passed on as far as Rudok, at the north-west extremity of Chinese Thibet, on the frontier of Ladak, and on his way back from Rudok visited the gold fields of Thok Nianmo, Thok Sarlung,‡ and Thok Jarlung. The map which accompanies Major Montgomery's narrative of the journeys of the Pundits gives in addition the gold fields of Thok

* "Verhand. Kgl. Danischen Gesellsch. der Wissensch." for 1070. Printed separately in Danish, German, and French.

† Vol. iv. p. 225.

‡ Thok Sarlung had at one time been the chief gold field of the district, "but had in a great measure been abandoned on the discovery of the Thok Jarlung gold field. The Pundit passed a great excavation some 30 to 40 feet deep, 200 feet in width, and two miles in length, from which the gold has been extracted."—*Jour. Asiatic Soc. Bengal*, vol. xxxix. pt. 2, p. 53. 1870.

Munnak, Thok Ragyok, Thok Ragung, and Thok Dalung. . . . . The miners' camp at Thok Jarlung, according to the measurements of the Pundits, is 16,300 feet above the sea level.

The cold is intense, and the miners in winter are thickly clad with furs.

The miners do not merely remain under ground when at work, but their small black tents, which are made of a felt-like material manufactured from the hair of the Yak, are set in a series of pits, with steps leading down to them . . . . seven or eight feet below the surface of the ground. . . . . Spite of the cold the diggers prefer working in winter; and the number of their tents, which in summer amounts to 300, rises to nearly 600 in winter. They prefer the winter as the frozen soil then stands well, and is not likely to trouble them much by falling in.

They are occasionally attacked by bands of robbers who carry off their gold.

Sir Henry Rawlinson's remarks on these reports of the Pundits' researches and travels are as follows :*—

Now, then, for the first time, we have an explanation of the circumstances under which so large a quantity of gold is, as is well known to be the case, exported to the west from Khoten, and finds its way into India from Thibet; and it is probable that the search for gold in this region has been going on from a very remote antiquity, since no one can read the ex-Pundit's account of the Thibetan miners "living in tents some seven or eight feet below the surface of the ground, and collecting the excavated earth in heaps previous to washing the gold out of the soil," without being reminded of the description which Herodotus gives of the "ants in the land of the Indians border-

* *Pall Mall Gazette*, March 16, 1869, quoted in "Indian Antiquary," vol. iv. p. 225.

ing on Kaspatyrus (or Kashmir), which made their dwellings underground and threw up sand heaps as they burrowed, the sand which they threw up being full of gold."

Professor Schiern points out that the tradition was mentioned in writings of the Middle Ages, and those by Arabian authors. It survived among the Turks. Strabo and Albertus Magnus treated the whole story as a fiction. Xivrey supposed that the animals had become extinct owing to the *auri sacra fames.* Major Rennell supposed that the dwellers in mounds were *termites* or white ants. Humboldt's observations in Mexico on the habit of certain ants to carry about shining particles of hyalith was quoted by those who believed that the animals were really ants. Other authorities suggested that they were marmots, jackals, foxes, or hyænas. Pliny having stated that horns of the Indian ant were preserved in the temple of Hercules at Erythræ, Samuel Wahl, who maintained the hyæna theory, proved equal to the difficulty by suggesting that the horns might have been a *lusus naturæ.*

Professor Schiern most ingeniously argues that the horns had been taken from the skins of animals which formed the garments of the miner. I am informed by my colleague, Mr. Lydekker, that a common form of pickaxe in use by miners in Ladak and Kashmir consists of the horn of the wild sheep, tipped with iron and set in a handle. The ant's horn at Erythræ was therefore more probably one of these.

Professor Schiern further points out that ancient writers say that the ants worked chiefly in winter, and connects this with the statement of the Pundit above quoted.

In conclusion he writes :—

For us the story partakes no longer of the marvellous. The gold-digging ants were originally neither real ants, as the ancients supposed, nor, as the many eminent men of learning have supposed, larger animals mistaken for ants on account of their subterranean habits, but men of flesh and blood, and these men Thibetan miners, whose mode of life and dress were in the remotest antiquity exactly what they are at the present day.

I append an extract from Sir Henry Rawlinson's translation of the passage in Herodotus, as it may be of interest to some readers:—

Besides these there are Indians of another tribe, who border on the city of Kaspatyrus and the country of Paktyika: these people dwell northward of all the rest of the Indians, and follow nearly the same mode of life as the Bactrians. They are more warlike than any of the other tribes, and from them the men are sent forth who go to procure the gold, for it is in this part of India that the sandy desert lies. Here in this desert there live, amid the sand, great ants, in size somewhat less than dogs, but bigger than foxes. The Persian king has a number of them, which have been caught by the hunters in the land whereof we are speaking. These ants make their dwellings underground, and, like the Greek ants, which they very much resemble in shape, throw up sandheaps as they burrow. Now, the sand which they throw up is full of gold. The Indians, when they go into the desert to collect this sand, take three camels and harness them together, a female in the middle, and a male on either side in a leading-rein. The rider sits on the female, and they are particular to choose for this purpose one that has just dropped her young; for their female camels can run as fast as horses, while they bear burdens very much better. . . . . When, then, the Indians reach the place where the gold is, they fill their bags with the sand and ride away at their best speed; the ants, however, scent-

ing them, as the Persians say, rush forth in pursuit. Now, these animals are so swift, they declare, that there is nothing in the world like them; if it were not, therefore, that the Indians get a start while the ants are mustering, not a single gold-gatherer could escape. During the flight the male camels, which are not so fleet as the females, grow tired, and begin to drag, first one and then the other, but the females recollect the young which they have left behind, and never give way or flag. Such, according to the Persians, is the manner in which the Indians get the greater part of their gold; some is dug out of the earth, but of this the supply is more scanty.

APPENDIX.

IDENTITY OF THE GREAT MOGUL DIAMOND WITH THE KOH-I-NUR.

IT will be well to begin by quoting *verbatim*, and then analysing what Tavernier has written regarding the Great Mogul diamond. Having gone to take leave of the Great Mogul (Aurungzeb) on the 1st of November, 1665, he was invited to return on the following morning to see the Emperor's jewels. He says :* "The first object which Akel Khan (the custodian of the jewels) put in my hands was the great diamond, which is a rose, round, very convex (?) (*haute*) on one side ; at the edge of one side there is a small notch (*cran*) with a flaw in it. The water is perfection, and it weighs 319½ ratis, which are equal to 280 of our carats, the rati being ⅞ of a carat. When Mirgimola, who betrayed the King of Golconda, his master, made a gift of this stone to Sha Jehan, from whom it is descended, it was uncut, and weighed 900 ratis, which are equal to 787 carats and a half, and it had many flaws. If this stone had been in Europe it would have been differently treated, for some good pieces would have been taken from it, and the stone left much larger ; as it is, it has been almost polished away. It was *Sieur* Hortensio Borgio, a Venetian, who cut it, for which he was badly paid. They reproached him with having spoilt the stone, which ought to have remained heavier, and instead of

* "Travels," vol. ii. livre ii. p. 249. Paris: Ed. 1677.

paying him the Emperor made him pay a fine of 10,000* (*dix mille*), and would have taken still more if he had possessed it. If Hortensio had known his work better, he might have taken some good pieces off without doing injury to the king, and without having expended so much trouble in polishing it; but he was not a very accomplished diamond cutter."

In the chapter on his visit to the mines at Gani-Colour—*i.e.*, Kollur,† he says that the Great Mogul diamond was found there. If this be true, and also that these mines were only discovered about 100 years before his visit in 1665, then this diamond cannot have the great antiquity claimed for it by some of those who consider it to be identical with the Koh-i-nur.

Tavernier's third mention of it, accompanied by a figure (reproduced in the "Encyclopædia Britannica"), is as follows :—

"This diamond belongs to the Great Mogul, who did me the honour to show it to me with all his other jewels. One sees the form which it received on being cut. On my being permitted to weigh it, I have found its weight to be $319\frac{1}{2}$ ratis, which are $279\frac{9}{16}$ of our carats. In its rough state it weighed, as I have said, 907 ratis, which are $793\frac{5}{16}$ carats. The stone has the same form as if one cut an egg in two."

He gives us, therefore, two different accounts of its weight in the rough : 900 ratis, or 787 carats, and 907 ratis, or $793\frac{5}{16}$ carats. It is obvious that there is a mistake, as the two do not agree in any respect, even the equivalent values, calculated at 1 rati$=\frac{7}{8}$ of a carat, should be $787\frac{1}{2}$ and $793\frac{5}{8}$. This is one of several strange and unaccountable defects in Tavernier's arithmetic. They can scarcely be due to misprints.

* Even this item is variously stated by compilers, who seem to have made much of the confusion that exists about the weights, &c., of this historical gem.

† *Loc. cit.* p. 305.

Different weights and measures appear to have been used in different parts of the country—the Mangelin = $1\frac{3}{4}$ carats, or 7 grains, at Raolconda and Colour; the rati = $\frac{7}{8}$ of a carat, or $3\frac{1}{2}$ grains, at Soumelpur.

If we could with appropriate accuracy fix the value of the rati, or rutti, mentioned by Tavernier, we might succeed, perhaps, in instituting a fair comparison between the Great Mogul and other diamonds. It seems to be difficult to believe that it weighed $3\frac{1}{2}$ grains, as he states. In Nagpur, in the year 1827, according to Mr. Jenkins, the rati weighed only 2·014 grains. But it is necessary to bear in mind that the French grain is only equal to about ·77 of a troy grain; therefore, since the rati contained $3\frac{1}{2}$ of these, its value would have been 2·695, or say 2·7 grains troy. This fact seems to have been overlooked by some who have endeavoured to reduce the weights given by Tavernier. Non-experts, too, appear to have forgotten that the diamond grain is not identical with any other grain; though an English carat contains four of these grains it only consists of 3·174 troy grains;* so calculated, the weight of the Great Mogul would be $\frac{319{\cdot}5 \times 2{\cdot}7}{3{\cdot}174} = 271{\cdot}84$ English carats. If in this calculation we could feel justified in placing the value of Tavernier's rati at 1·84 grains troy instead of 2·7 grains, the exact weight of the Koh-i-nur would be obtained. Another system of calculation is used by the writer of a Note in the Great Exhibition Catalogue of 1851, in which he adopts the known maximum weight of a rati at $2\frac{5}{16}$ grains (what grains?), and thence deduces 175 carats as the weight of the Great Mogul. This is somewhat short of the $186\frac{1}{16}$ carats of the Koh-i-nur, while the other is too large. If the Koh-i-nur be identical with the Great Mogul, it may have been operated upon during its travels, and this may account for the difference in weight (271·78 — 186·06 = 85·72 loss), and in its shape when brought to England from the sketch given by Tavernier. It is probable, however, that

* *Vide* "Encyclopædia Britannica," art. Diamond.

Tavernier's sketch was from memory, and was, therefore, more regular in outline than the original.

The name Great Mogul was, of course, not of native origin, but was probably first conferred by Tavernier. By the natives it was originally, in all probability, known as the Kollur diamond. In reference to this, I was quite accidentally informed by a native jeweller of Calcutta that it has been suggested, if not actually stated, by some native writers, that the title Koh-i-nur really owes its origin to a change in the originally meaningless name Kollur; such changes in which, while the sound is more or less retained, a meaning is acquired, are not by any means rare in Oriental languages, while they sometimes occur in those of Europe.

Thus English surnames in the mouths of natives become changed into words of similar sound, which have a meaning in Hindustani, or whatever the language spoken may be. A striking example is afforded by the name given by the natives to the geological department. The word geological being unintelligible and difficult of pronunciation, has been rejected, and is replaced by one of somewhat similar sound. This is *jauhari*, and geologists are commonly known as Jauhari Sahibs, or jewellers, it being supposed that their investigations all have for their object the discovery of precious stones. Other and similar examples might be quoted in illustration.

From the above I think it will be admitted that there are good reasons for concluding that the Great Mogul, or Kollur diamond of Tavernier, is identical with the Koh-i-nur.

Those who have hitherto held this view have stated that it came from either Gani or Purtial. As for Gani, it is not a name, being simply a corruption of *Kan-i*, a prefix signifying "mine of;" while Purtial is a mine situated twenty-four miles east of Kollur, where a mine is also known to have existed, being represented on a map of the Nizam's dominions by Col. Colin Mackenzie, dated 1798.

NOTE ON MYTH REGARDING THE METHOD OF OBTAINING DIAMONDS DESCRIBED IN THE TRAVELS OF MARCO POLO, SINDBAD, ETC.

AS not improbably referring to Beiragurh, the modern Weiragurh, it may be of interest to add the following from the account* of the "Travels of Nicolo Conti" in the early part of the fifteenth century. I cannot agree with the writer of the Introduction to the volume containing the account that Golconda was intended. Nicolo Conti says that at fifteen days' journey north of Bizengulia (by which Vijayanagar, the modern Bijapur is perhaps meant) there is a mountain which produces diamonds called Albenigaras. Now Beiragurh, the modern Weiragurh, is, as the crow flies, about 324 miles north-eastwards of Bijapur, and therefore within a possible fifteen days' journey, though as the actual distance traversed would be greater, it would mean very hard travelling. However, *Al*-benigaras looks so like Beiragurh with the Arabic prefix El' or *Al'*, that I am inclined to believe that it was the place intended. He goes on to say that the mountain being infested with serpents, it is inaccessible, but is commanded by another mountain somewhat higher. "Here at a certain period of the year men bring oxen, which they drive to the top, and having cut them into pieces, cast the warm and bleeding fragments upon the summit of the other mountain by means of machines, which they construct for the purpose. The diamonds stick to these pieces of flesh. Then come vultures and eagles flying to the spot, which seizing the meat for their food fly away with it to places where they may be safe from the serpents. To these places the men afterwards come and collect the diamonds

* "India in the Fifteenth Century," Hakluyt Soc. p. 29.

which have fallen from the flesh." Nicolo Conti continues with an account of how other less precious stones are obtained, and his description is that of ordinary Indian diamond mining. "The Travels of Sindbad the Sailor"* and of Marco Polo, whose accounts apparently refer to localities in Golconda, on the Kistna, have made this tradition of throwing pieces of meat where the diamonds may stick to them familiar to most people; yet an adequate explanation of the origin of the myth does not appear to have been offered hitherto. I believe the following to be a complete and probable one:—

Heyne, in the account of his visit to the mines at Kadapah (Cuddapah), states that they were under the particular protection of Ammawaru (the sanguinary goddess of riches), and the miners objected to his riding on horseback up to the mines for fear of offending her. Now what can be more probable than that the miners before opening a new mine, in order to invoke the aid of this sanguinary goddess, made an offering to her of cattle or buffaloes. The opening up of new mines was, and is, we are told by several authorities, preceded by various rites and ceremonies. The miners were probably never Hindus, and the custom of offering up cattle in sacrifice by the aboriginal tribes, from the Todas to the Sontals, is too well known to require special illustration. Admitted that the opening of a mine was preceded by the sacrifice of cattle, and the throwing of the fragments of the flesh to be devoured by the fowls of the air, we at once arrive at the foundation of fact upon which this superstructure of fable has in all probability been erected.

Casual spectators and travellers may very easily have supposed that the throwing about pieces of meat was an essential part of the operations; and any one with experience of how Oriental imaginations can erect a tale of fiction on a small substratum of fact, will find no difficulty

* These have been well called a repertory of Arabian myths and traditions.

in conceding that in the above supposition there is a sufficient explanation for the origin of the whole story.

It may be added that this propitiation of malefiant spirits was, and is, by no means limited to mining operations connected with diamonds. In the "Journal of the Asiatic Society of Bengal"* will be found an account of one of the richest gold-bearing tracts in Assam, which had been deserted by the indigenous gold-washers in consequence of the expense connected with the propitiation of the evil spirits who guarded the mineral treasures being greater than they could afford to pay.

Having mentioned the Assam washings here, I avail myself of the opportunity of saying that a statement recently made,† that they yielded annually 40,000 ounces of gold is, I believe, due to some mistake. The earliest record I know of mentions a gold revenue enjoyed by the Kings of Assam which amounted to 40,000 rupees *worth*, not ounces!

* Vol. xxii. p. 511.

† "Jour. Soc. of Arts," vol. xxix. p. 244.

THE END.

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